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THE SCREW PINE (PANDANUS) AND ITS ALLIES.

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(With a Coloured Plate.)

It was Linnæus who first called the Palms the princes of the vegetable kingdom, which opinion has since been endorsed both by botanists, as well as thousands of other admirers of Nature. If, then, the Palms offer so much attraction, both to the scientific and general observer, the Screw Pines must also claim a proportionate share of interest, inasmuch as they partake, on the one hand, somewhat of the habits of the Palms, namely, in their foliage; while they incline to exogens in their manner of branching. They are also peculiar in various other points, which we shall presently explain.

The exact natural position of the Pandanaceæ—that is, the classification as to their relations with other natural families—has been a subject of great difference of opinion amongst many of our eminent botanists. Lindley, writing on this order, says:—"The species of Pandanus and Freycinetia have the aspect of gigantic Bromelias, bearing the flowers of a Sparganium. While there is no analogy with the former in structure, beyond the general appearance of the foliage, the organization of the fructification bears so near a resemblance to the latter, as to have led to the combination of Screw Pines and Typhads by botanists of the first authority. But when we contrast the naked flowers, the compound, highly developed fruit, the spathaceous bracts, the entire embryo, and the arborescent

habit of the former, with the half-glumaceous flowers, the simple fruit, the want of spathaceous bracts, the slit embryo, and the herbaceous, sedgy habit of the latter, it is difficult to withhold our assent from the proposition to separate them. Brown remarks that these have no affinity with palms beyond their arborescent stems. But, on the contrary, Cyclantheæ, which, following Poiteau and others, I formerly adopted, have, with the structure of Pandaneæ proper, the foliage of palms, and are, in reality, a connecting link between the two orders." Further than the opinions here expressed, and as other proofs, also, of the tendency of plants to incline towards two or more orders, may be mentioned the Vegetable Ivory Palm, which, though now acknowledged to be a true palm, was referred, by Endlicher and other authorities, to the Pandanaceæ. *Nipa fruticans* is also another instance of an intermediate plant which we shall have occasion to refer to more fully as we go on.

Screw Pines are natives of tropical regions; are abundant in the islands of the Indian Archipelago, and in most of the tropical islands of the Old World, but rare in America; the section Cyclantheæ, on the contrary, being exclusively confined to that continent.

The Order is divided, as previously stated, into two sections:—I. Pandaneæ, in which the leaves are undivided, or simple, and the flowers naked—that is, without a perianth; and II. Cyclantheæ, where the leaves are flabellate (fan-shaped) or pinnate, and the flowers mostly with a calyx. The first section includes the genera Pandanus, Marquartia, and Freycinetia. The second includes Cyclanthus, Carludovica, and, according to some authorities, Nipa.

Pandanus, of course, is the principal genus of the family, and is characterized by its diœcious flowers—that is, the two sexes being on different plants. The male spadix is composed of numerous small spikes, which are crowded with the small flowers. The female is a round, or sometimes oblong, head, composed of a quantity of small ovaries, very closely packed together, and each of which contains one ovule. The fruits are made up of a number of wedge-shaped drupes, clustered together in the form of a cone, which vary much in size in the different species—some being fully as large as a child's head, while others are scarcely larger than a moderate-sized pine-cone. They vary, also, in shape, being either globular or somewhat oblong. The leaves are for the most part long, narrow, thick, and somewhat leathery, and have, arranged along their edges, as well as along the midrib, a very perfect row of small recurved spines, very sharp, and exceedingly liable to catch the clothing or

flesh of any one coming in contact with them; which, on account of their fineness and light colour making them almost imperceptible, one is very apt to do. These leaves are also remarkable for their uniform spiral arrangement round the axis of the stem, and forming tufts at the ends of the branches, which are arranged at the top of the tall, straight stem, or trunk, in some species, thus giving the plants somewhat the aspect of palms. In other species, however, as will be seen hereafter, the branches are more irregularly given off, the leaves being always in spirals at the ends of the branches. The whole of the naked stems and branches are marked by the scars of old leaves which have fallen off.

The two forms here mentioned are very well shown in the Plate, which is a copy of a painting in oil colours—probably the first landscape ever painted on the Zambesi—by T. Baines, Esq., whose paintings of the Victoria Falls and other African scenery are so well known, and who has kindly given me permission to have the painting copied, the original of which is in the Museum of the Royal Gardens, Kew. I am also indebted to Mr. Baines for the following information as to the locality where the sketch was made:—Some miles from the mouth of the Zambesi, as the mangroves (which have performed their office in converting the accumulating shoals into land capable of bearing a superior vegetation) begin to be supplanted by other trees, the most striking feature in the landscape is the tall Pandanus, which towers above the brush that skirts the various channels of the delta, and in the distance especially, when thickly draped with creeping plants, presents the appearance sometimes of poplar groves, and sometimes of village spires; it seems to begin where the mangrove—*i. e.*, the kind which forms the advanced guard in reclaiming the land from the sea—begins to cease, and where palms of various kinds—dwarf fan palm, wild date, Doum palm, zamias, a kind of Strychnos (*Brehmia spinosa*?), bearing an orange-shaped fruit, large flowering Hibiscus, and occasional cocoa-nuts—begin. Some of these channels are so narrow, that in passing through, the vessel would brush the reeds on both sides, while the main streams would be several hundred yards in width. The specimens shown in the sketch were situate in a perfect tangle of old mangroves, with their aërial roots and luxurious vegetation overgrowing them, so as to conceal and render more precarious the treacherous footway over which we have to pick our way. The tree was covered with convolvulus, and was exceedingly beautiful. This was within the tidal influence, and the stream would be brackish at high water, or fresh when the volume

of the river was sufficient to overpower the tide. These Pandani did not appear to extend far beyond where the river ceased to be brackish.

As many as thirty species of Pandanus have been enumerated. The chandelier tree (*P. candelabrum*), however, is perhaps one of the most striking in appearance of all the species. The branches spread out all round the trunk, bending gracefully downwards, and the ends again inclining upwards, where they are crowned with the tuft of bright green leaves. This arrangement is shown (as well as it can be in so small a sketch) in the trees at the left hand of the plate. This species, like some of its fellows of large or tree-like growth, is provided by nature with numerous aërial roots, as may be seen in foremost tree in the Plate. These roots are thrown out all round the stem, and at irregular intervals from each other—sometimes a group of two or three being so close together as to appear almost united, and at other times a solitary one may be seen branching conspicuously by itself. They are usually most numerous near the ground, and are frequently so thick as to completely obscure the original trunk, but they are by no means confined to the lower part of the trunk. At a distance of some feet from the ground they may be seen either breaking through the epidermis or bark, or hanging down, ready to bury themselves in the soil. A full-grown Pandanus, so supported, has about its lower extremities somewhat the appearance of a mangrove-tree; the aërial roots of the latter, however, branch and curve in a much more irregular manner, which is the nature of dicotyledonous trees to do, while in the families allied to the Screw Pines the contrary is the case. The tips or spongioles of these aërial roots, as they hang from the trunks, are protected by thin woody caps, which fall off or decay when the roots touch the ground. The fruit of *Pandanus candelabrum* is nearly round, and is composed of a series of sub-compressed, ovate, angular, drupaceous nuts or seeds, having an exceedingly hard and bone-like centre, with a stiff fibrous coating, which, when fresh, is covered with pulpy or fleshy matter. The shape and appearance of the fruit is not unlike the bread-fruit; and if it were more elongated, it would much resemble a pine-apple, except in colour, being mostly of a dark green, but yellowish towards the lower part; the apex of each of the drupes is crowned with from four to six brownish sessile stigmas. *Pandanus odoratissimus, L. fil,* is, perhaps, one of the most useful species, in an economic point of view. It is a plant some ten, twelve, or more feet high, with spreading, irregular branches, and closely imbricated

leaves, arranged in three spiral rows round the ends of the branches. It grows in the islands of the Pacific Ocean, China, and the East Indies, being common along the banks of the canals and back-waters of Travancore, where it is planted for the purpose of binding the soil. The long leaves are full of tough fibres, which are used for making cordage of various thicknesses, as well as for making hunting-nets, and the drag-ropes of fishing-nets. Matting of all descriptions is likewise made from them. Some of the sleeping-mats, which are dyed or stained various colours, are fine specimens of native plaiting. The leaves are likewise used to make umbrellas, and they are said to furnish an excellent material for paper-making.

The fibre from the leaves is commonly used in Tinnivelly, when mixed with flax, for making ropes. The aërial roots are applied to a variety of purposes in India. Manufactories exist in some localities where hats, baskets, mats, etc., are made from them. On account of their light spongy nature, they make excellent stoppers for bottles in lieu of cork, and the more fibrous part, when beaten out and the pulp removed, is used for brushes for whitewashing, painting, etc. The roots are used medicinally by the native practitioners, and an oil prepared from them has the repute of being a cure for rheumatism. The flowers are odoriferous, as the specific name indicates. Besides the numerous uses already mentioned, the inner or pulpy part of the drupes is eaten as an article of food in times of scarcity. In some parts of N. Australia, indeed, the fleshy drupes of the Pandàni are commonly eaten, being held in the mouth and sucked until the fleshy portion is consumed. In the Society Islands the women make very beautiful mats of the leaves, which are first prepared by burying them in the sand near the sea for about a month; this makes them soft, they are then carefully scraped with a shell which removes all irregularities, leaving that portion of the leaf intended for use fine and soft; the more care exercised in this preparation the finer and softer are the mats. After being thus prepared, the leaves are drawn across the edge of a shell previously notched or toothed at regular intervals, by which means they are divided into long narrow strips of equal width and are ready for plaiting.

P. utilis, Bor., as its name implies, is another most useful species. Most of us have some acquaintance with the leaves of this plant. The sacks or bags in which the Mauritius sugar is imported are made from them, and these bags, after discharging their principal duty in bringing sugar to this country, are sold to the fishmongers, who use them for making bags or baskets for packing fish. The plant is a very common one in the Mauritius, and, further than

this, is also largely cultivated there for the sake of its leaves for bag-making.

Mr. Ellis, in his "Visits to Madagascar," says:—

"The Pandanus exhibits a form of growth peculiar to the vegetation of the sea shore in many tropical regions. It thrives well in pure sand near the water's edge. It is also an exceedingly useful tree. The trunk is durable, and is employed in the structure and fitting of native canoes. The leaves in the South Sea Islands, make excellent thatch, and the fruit or nuts are baked and the kernels eaten. In Madagascar the leaves are used chiefly for covering packages to exclude rain during transit from the coast to the interior. It is extensively cultivated in Mauritius, and its leaves used for making bags, large quantities of which are brought from the Seychelle Islands, and all the sugar produced in Mauritius is exported in bags made from the leaves of this singularly growing but useful tree."

Referring to other species growing in Madagascar, the same writer continues:—"I had seen nothing either in the Mauritius or Polynesia resembling them, especially one kind seldom attaining above ten or twelve feet in height, having a number of leaves in the centre of the crown, apparently glued or stuck together at their extremities, giving to the centre, or crown, a singular form; while the disentangled leaves that stretched out horizontally or hung down parallel with the stem, seemed very much like the leaves with which the Chinese line their tea-chests." "Another species of Pandanus was to me equally new and remarkable. The stem of this was straight as that of a fir-tree, and the branches horizontal with feathery tips of flag or short ribbon-formed leaves. The tree was frequently forty or fifty feet high, crowned with an upright plume, and at a distance might have been mistaken for a larch, but for its stiff and formal growth. I did not see it near the shore, but amongst the low wet places inland."

The leaves of several other species are used by the natives in the countries where they grow for plaiting, for making mats, etc. Freycinetia is a genus composed chiefly of climbing trees, and, like the Pandani are natives of tropical countries, being found in the Sandwich Islands, New Zealand, the Islands of the Indian Archipelago, Norfolk Island, etc. Botanically, Freycinetia is chiefly distinguished from Pandanus by the stamens of the female flowers being abortive, and the division of the ovary by three parietal placentæ, the male spadix unbranched, and the fruit composed of a number of fleshy drupes apparently merged into one mass. The Freycinetias abound

in swampy forests, many of them clinging to trees and imparting to the trunks a peculiar appearance by their long and narrow leaves. These leaves are used for similar purposes to those of the Pandani, namely for plaiting into mats, etc. When dried and properly prepared they are exceedingly fine as regards the texture, and very white in colour.

Carludovica is a small genus, some species of which, like the Freycinetias, are climbing or epiphytal on the trunk of trees, and have aërial roots which hang down like so many ropes or cords, others are terrestrial, growing in dense thickets. They are almost exclusively confined to the tropical part of South America; one species, however, *C. Plumieri*, Kth., being found in Dominica and Trinidad, and two other species, in the French West Indian Islands. The flowers, which are monœcious, are beautifully arranged in squares closely packed together and forming a cylindrical spike or spadix. Each female flower is in the centre of one of these squares, and is surrounded by the males, four in number. The stigmas are sessile upon these small square ovaries or berries, which impart to the spike a very uniform pattern.

Carludovica palmata, R. et P., is the most valuable and interesting of all the species; it is the plant from whose leaves the celebrated Panama hats are made. Dr. Seemann, who has travelled much in South America, has given such an excellent account of this plant and its uses, that we cannot do better than give it entire. He says:—"The leaves are from six to fourteen feet high, and their lamina about four feet across. The spathe appears towards the end of the dry season, in February and March. In the Isthmus, the plant is called *Portorico*, and also *Jipijāpa*, but the latter appellation is most common, and is diffused all along the coast as far as Peru and Chili; while in Ecuador a whole district derives its name from it. The Jipijapa is common in Panama and Darien, especially in half shady places; but its geographical range is by no means confined to them. It is found all along the western shores of New Grenada and Ecuador; and I have noticed it even at Salango, where, however, it seems to reach its most southern limit, thus extending over twelve degrees of latitude, from the tenth N. to the second S. The Jipijapa, or Panama hats, are principally manufactured in Veraguas and Western Panama; not all, however, known in commerce by that name are plaited in the Isthmus; by far the greater proportion is made at Manta, Monte Christi, and other parts of Ecuador. The hats are worn almost in the whole American continent and the West Indies, and would probably be

equally used in Europe, did not their high price, varying from two to 150 dollars, prevent their importation. They are distinguished from all others by consisting only of a single piece, and by their lightness and flexibility. They may be rolled up and put into the pocket without injury. In the rainy season they are apt to get black, but by washing them with soap and water, besmearing them with lime-juice or any other acid, and exposing them to the sun, their whiteness is easily restored. So little is known about these hats, that it may not be deemed out of place to insert here a notice of their manufacture. The 'straw,' previous to plaiting, has to go through several processes. The leaves are gathered before they unfold, all their ribs and coarser veins removed, and the rest, without being separated from the base of the leaf, is reduced to shreds. After having been put in the sun for a day, and tied into a knot, the straw is immersed in boiling water until it becomes white. It is then hung up in a shady place, and subsequently bleached for two or three days. The straw is now ready for use, and in this state sent to different places, especially to Peru, where the Indians manufacture from it those beautiful cigar cases, which fetch sometimes more than £6 a-piece. The plaiting of the hats is very troublesome. It commences at the crown, and finishes at the brim. They are made on a block, which is placed upon the knees, and requires to be constantly pressed with the breast. According to their quality, more or less time is occupied in their completion; the coarser ones may be finished in two or three days, the finest take as many months. The best times for plaiting are the morning hours and the rainy season, when the air is moist; in the middle of the day and in dry, clear weather, the straw is apt to break, which, when the hat is finished, is betrayed by knots, and much diminishes the value."

Though the plaiting of these hats is so exceedingly fine, irrespective of the high price, some modification would be required in the ordinary shape of a Panama hat for them to be more generally worn in this part of Europe.

At the commencement of this paper, in speaking of the division of the order into two sections, we included the genus Nipa, in the second division, as a very doubtful member, and promised to refer to it more fully hereafter. We are not sure, however, whether it should be included at all. The question as to its proper position being still an undecided one, the first authorities themselves being doubtful whether to put it with Palms or Pandanus. The genus is represented by only one species, *Nipa fruticans*, Humb. It abounds

in the salt marshes of the islands and coasts of the Indian Ocean, where it covers thousands of acres. It is a low-growing, stemless plant, with pinnatisect, feathery leaves, often more than twenty feet long. The flowers are monœcious—that is, with the males and females on the same plant, and they are enclosed in a spathe similar to that of a palm. The fruits are composed of a number of one-seeded drupes, forming large round bunches quite the size of a man's head; the kernels or seeds of which are eaten. In the Philippine Islands and Borneo, a kind of toddy is obtained from the spathe, from which sugar, syrup, and a strong spirit is manufactured. The leaves are commonly used for thatching houses, and are said to be very durable, large quantities of them are sent northward from the provinces of Tenasserim for this purpose. They also yield a large quantity of salt when burnt. The fruits are found floating about in the Indian Ocean, and indeed are often carried to far greater distances. One specimen, for instance, in the Museum at Kew, was picked up on the coast at Freemantle, Western Australia. Dr. Hooker, in his "Himalayan Journals," says they were frequently tossed up by the paddles of the steamers at the mouths of the Ganges.

Besides the botanical interest of this plant, it is, as Dr. Hooker says, of great interest to the geologist from the nuts of a similar plant, abounding in the tertiary formations at the mouth of the Thames, and having floated about there in as great profusion as it does in the Indian Seas at the present time, till found deep in the silt and mud that now forms the Island of Sheppey.

THE SILKWORM DELUSION.

BY SHIRLEY HIBBERD.

VERY much has been written on the possibility of cultivating silk in England, and it is an article of popular belief that it *might* be done and leave a fair margin of profit (perhaps more) as a commercial undertaking. There are several books treating of the Ailanthus silkworm, which feeds upon a hardy tree and requires very little care, and produces a great quantity of silk which is wonderful in texture, and in value, therefore——but let us wait to ascertain its value, till we see it in the market.

The Oak-tree silkworm, too, is offered us as admirably adapted for silk production in this climate; and, as we have an abundance of oak-trees, what is there to hinder us from converting woods and coppices into silk districts? Well, it is time to ask seriously, can it be done? and as respects experiences acquired in certain quarters of this tight little isle, I am here to-day to pronounce the whole affair a mockery, a delusion, and a snare. For the sake of conciseness, decisiveness, and some other considerations of less consequence to the reader, than to the persons engaged in the silkworm experiences, I shall put myself in an ideal position, and speak as having had a hand and a purse in this business, so as to avoid referring to a mysterious "they" in any part of the story, which I assure you is true in every jot and tittle, bar the *personnel*, which really cannot matter.

Well, I was fired with enthusiasm about this silkworm business, and believed that therein were the germs of an undeveloped industry to which I was bound in conscience and patriotism to play the part of pioneer. I went to work in earnest with ten thousand pounds at command, and a small stock of knowledge respecting the history and habits of *Attacus cynthia*, alias *Bombyx cynthia*, and the tree the insect loves, *Ailantus glandulosus*. The first step was to purchase an estate of a thousand acres, more or less, in a district where land and labour were low priced, and the climate is of a more equable nature than in almost any other part of Great Britain. We then dreamed of some day changing the name of Broadbury to Attacacia, or Sericaria, and, at all events, we took serious measures for locating on the spot a sufficient population for the industry that was to be developed, and we have the plan of a village (on paper) which really must have been built had the two A's (viz. the Attacus and Ailant)

proved as faithful to us as we were devoted to them. Well, it appeared that we had the right sort of climate, and the right sort of soil, and we started fair by laying down four hundred acres in Ailant. There were many difficulties to be overcome. We were much troubled to obtain seed of the tree, but at last M. Vilmorin, of Paris, helped us out, and we purchased many tons of seed of him. A still greater trouble occurred in respect of worms, but we got a few bushels of eggs at last, and Ailanti-culture was commenced with a prospect as bright as I had ever seen it, even in my dreams.

The routine of culture has been told in all the books, the writers whereof have learnt it by help of two or three trees and a few hundred worms. Our operations were on a somewhat larger scale than we have read of in the books. The land was drained, ploughed, and cleaned. The seed was drilled in rows two feet apart, and, generally speaking, made a good start and grew into trees six inches high the first season. In 1861 we put out worms on about one hundred acres. We learnt to deal with the insect thus:—A number of tiffany sheds were built; the cocoons, being all strung on cords like necklaces for savages, were suspended in these sheds, and in due time the moths came out and completed their life's career under canvas. We tried glass houses, which were useful all winter, but in spring the tiffany answered best because being cool: the moths were not hastened into activity until the season was sufficiently advanced for them. It is almost a sufficient compensation for the loss of a few thousands in this business to call to mind the glorious appearance of a large clean tiffany tent planted full of Ailant bushes two or three feet high and crowded with the moths in their first days of transformed life and earnest courtship. It is but a short time they last, and then the cultivator considers what his gains are in empty cocoons and eggs. We shall come to the cocoon business presently; let us now consider about the eggs. After numerous experiments we found the only safe way to deal with these was to leave them alone in the coolest place that could be found for them, and where they were screened from sunshine and from wet. By keeping them cool the worms are not hatched until the trees bear leaves to feed them. If they are kept too warm they hatch into a world where their fate is starvation; and in spite of the utmost care this will sometimes happen, and is one of the greatest disasters incidental to the business. Our plan has always been to allow the young worms to spread about amongst the trees under cover as the season advances, and as they acquire enlarged appetites they are transferred by women and children to the open plantations, where they quickly

fix themselves on the undersides of the leaves, and hold as firmly there as if integral parts of the leaves themselves. Thus I have endeavoured, by the help of faithful co-workers and constant observation, to adapt this culture to English soil, and it is time the reader knew something of the results.

In 1861 we had a good year, and we were in good spirits. The trees had made a free growth, and the worms throve; cocoons were abundant. Now, the value of a cocoon is the fundamental item in the scheme of accounts of a silkworm farm. Know, then, that the cocoon of this Attacus (or Bombyx) does not yield a continuous thread. From the cocoon of the mulberry-worm, *Bombyx mori*, we may wind *a continuous thread* 1000 to 2000 yards in length; but from the cocoon of the Ailant worm *you cannot wind a continuous thread at all*. The cocoon is in form elliptical, pointed at each end, and looks very much like a dirty brown nut. Hundreds of ropes of them dangle about and around me as I write this, mockeries of my sacrifice, my blighted hopes, my wasted enthusiasm. You cannot wind the silk, therefore it must be carded, just as, in the cotton manufacture, carding is performed in order to arrange the fibres. Well, when it is carded, its value is such that it stands *lowest in the scale of all known silks that come into the market*. It is weak, it lacks lustre, IT IS TRASH! Yet, in spite of these facts, the year 1861 was so good that we saw, through the returns, our way pretty clearly to realize a profit of ten shillings per acre, after allowing for all outgoings, and ten per cent. on the cost of the land. When I had fully made up my mind to this, I began to enlarge the operations. The year 1862 was a good year, and the profits were about eight shillings per acre. The year 1863 was a bad year, for the trees came into leaf late, myriads of worms were hatched too early to be fed, and perished. We now began to discover that the practice of cutting down the trees annually to keep them dwarf, was likely to kill them in the end. It will be understood that the trees must not be allowed to get up higher than four or five feet, because although the worms hold fast, and insectivorous birds do not hunt them with great pertinacity, yet, if the trees were tall, the wind and the birds together would make considerable havoc. Yes, frequent cutting down reduces the vigour of the tree, and we can point to rows that have been left uncut and are full of vigour, while broad plantations that have been cut over annually are nearly killed out. The year 1864 was worse than '63, and this in spite of the continual enlargement of our operations and the acquisition of experience therefrom. The winter killed a great many trees, and the spring was cold.

The profits this year averaged about two shillings per acre. On the same land we were deriving £20 per acre profit by the cultivation of potatoes; and I then resolved to contract operations in silk, and enlarge in the way of corn and roots. The year 1864 was a good year; but a good year at this sort of work means a dedication of the land to the formation of a high road to the workhouse, for at the best the profits are nothing, the silk is trash, and you cannot be sure of obtaining a handful. I am positively happy—it may be a fiendish happiness, but I am happy to say that 1865 gave the silk business at Broadbury its death-blow. There came a smart frost after the trees were in leaf, and the worms were active in feeding. The worms were instantly *non est*, and the trees were black as if burnt. Then we resolved to restore the silk trade to its ancient and proper place in England, the realm of toys; and 200 acres of Ailant were ploughed up and sown with roots, and there was a real and good return for the outlay in the place of a mockery, a delusion, and a snare. This change of tactics was resolved on none too soon, for 1867 would have been one of the worst years in this melancholy history, for the winter killed many of the cut-down trees, the bitter frost in the middle of May afforded a gentle hint of the dangerous nature of this enterprise; and the prevailing cold, all the season through, even to the time of the spinning, would have crushed us, had we not already taken warning and given more attention to grain and cattle food, than to the wretched Ailantus. I have about twenty acres of the delusion left, and so much I propose to keep as an example and a warning. Besides, I am a little weak on the subject of hobbies, and cannot quite obliterate the worm from Broadbury, though it has cost me so much and so basely deceived me. The thousands of pounds invested in the silk business will not all be lost, for in place of Ailant we are establishing a great meat factory; and possibly, except the silkworm had coaxed me into these parts, the lands we are now tilling with advantage to ourselves and the community, might have remained in the state of waste in which I found them, when I made a bold bid for them in the capacity of the first producer of silk in England.

THE ROCKY MOUNTAIN GOAT.

BY JOHN KEAST LORD, F.Z.S.

(*With a Coloured Plate.*)

I KNOW of no animal so wild, solitary, and unsocial in its habits as the Rocky Mountain Goat. I first saw it in its native wilds, on the summit of the Rocky Mountains, near the Kootanie Pass. It was about midsummer, and, at that period of the year, the higher levels of the Rocky and Cascade Mountains are most delightful and enjoyable localities. The sun has by this time partially cleared away the winter's mantle of snow, and patches of bright green herbage spread out like well-kept lawns, stretching away from the bases of the glaciers, and down the slopes of the rocky cliffs, and wherever the regular drip of the melting ice and snow keeps up a kind of continual irrigation. Hardy flowers of semi-Alpine type overspread the moss-covered knolls, or push their bright corollas from out the clefts and chasms of the splintered rocks. The only tree that flourishes at all at this altitude is the *Pinus contorta*, and even that has a half-starved, stunted appearance. Everywhere the eye rests on huge piles of snow, that never entirely melt, but keep everything beneath them damp by the slow but steady slush of the thaw; and one might easily imagine the little oases of green discernible amid the heaped snow to be islands in a frozen sea.

Before, behind, to the right hand and to the left, immense pinnacles of rock seem to tower up into the very clouds. If you climb up as high as the snow and ice will permit, and scan the surrounding scene with a telescope, nothing is to be seen from sky-line to sky-line but one vast expanse of mountains of varying height and shape. Well may you pause, and wonder what power could have been adequate to pile up this great central axis of elevation. The stupendous immensity of everything round about seems to overwhelm and, if I may so say, absorb you. You feel like a mere atom amidst these, the grandest rocks in th world; and the more you ponder on this marvellous evidence of God's might and power, the more humbled and insignificant you feel in your own estimation.

Sitting down one bright, sunny day, half-dreamily contemplating the description of scene I have endeavoured to describe—for I felt very tired, from having had a tough and tedious climb to reach a ledge of rocks, from which I could, if I chose, without rising from a sitting posture, dip up the water that flowed, on the one side into the Atlantic, and on the other into the Pacific Oceans—

I was suddenly startled from my reverie by hearing some stones rattle down from the rocks above where I sat. Looking in the direction from whence the sound came, I espied a splendid specimen of the Rocky Mountain Goat. He was peering curiously at me, as though contemplating some strange apparition, quite new to his haunts. I thought I had never before contemplated so picturesque a sight as that wonderful animal perched upon a mere ledge of rock. A long, snow-white, shaggy coat hung down nearly to his hoofs. His mild but lustrous eye had a melancholy expression, which, together with his venerable beard and well-haired face, gave him a kind of human countenance; and one need not have stretched his fancy very much to have imagined that Hrymir, the Ice Giant, and no one else, had suddenly put in an appearance to know why a mortal invaded his domains. No thought of doing the goat any injury entered into my head just then. My daily hopes since I had been on the mountains were thus suddenly and unexpectedly realized. I could, and did for the first time, gaze upon a Rocky Mountain Goat amidst his native rocks. In nothing did this animal, to my mind, resemble a typical goat; but everything about it bore a much greater resemblance to the antelope tribe. The horns, the shape of the body, the peculiarity of coat, the slender but firmly-set limbs, were in nothing suggestive of a true goat. Having had a good look at him, I turned very gently round to place myself into a better position, so as to bring my field-glass to bear upon him. It was enough to warn the crafty beast that probably danger lurked in the stranger. With one bound he cleared a wide chasm intervening between the crag on which he stood and the adjoining pinnacle of rock, and, quick as a swallow, vanished from my sight as mysteriously as he had come.

Now that I discovered that goats were near my camping-ground, I spared neither time nor labour to watch their habits, and to obtain specimens. Very often I have tracked a small herd of them up some steep incline or rocky talus, and then have lost all further trace. Wandering on, half in hope and half in despair, suddenly I have espied a tiny party of goats, perhaps a patriarch and his three or four wives, and their children, slowly making their way round some splintered angle in the rocks; and as one by one they come in sight, following the male, who always leads, so they marched along in single file, deliberately, and, to all appearance, with the utmost carelessness, upon a narrow ledge of rock, where we would suppose a cat would be puzzled to find a secure footing—

above them a vertical wall of smooth rock, below them a precipice, perhaps hundreds of feet in depth. Fire at, or otherwise frighten them, and they gallop along this narrow footway as safely as they walked; and when any chasm had to be crossed, it was perfectly wonderful to watch the precision and certainty with which they, one after another, lighted upon the same spot, perching, more like birds than hard-hoofed quadrupeds, upon the smallest available projections. I very soon obtained some specimens of these most interesting animals, and here will be the best place to describe them. I am quite convinced that the so-styled goat of the Rocky Mountains is, in every one of its essential features and affinities, an antelope. It has nothing in common with animals of the domestic goat type, save and except such general characters as more or less belong to all ruminants related to it. In the jetty black, highly-polished, slender, conical, and slightly curved horns, the type of the chamois is most conspicuous; in other particulars it approximates the prongbuck.

The specific characteristics may be summed up as follows:—Horns small and symmetrical, conical, black, and slightly curved in a backward direction, the points sharp, and yellowish in colour, the base regularly ringed; nose ovine, and somewhat hairy; tear-bag and mouffle none; nostrils black; hoofs black; colour entirely white. The coat, which is remarkably thick, is composed of two classes of hair, the one extremely long and rather coarse, beneath which is a dense covering or fleece of wool, of the very finest class, quite as delicate in fibre and texture as that of the famed goat of Cashmere, from whose fleece such costly shawls are manufactured. There are rudimentary false hoofs, and a long pendant tuft of hair graces the chin. The size of the full-grown animal is rather larger than the average size of a domestic sheep. The outer covering of hair is extremely long, and hangs down all over the body, tail, and upper part of the legs, reminding one very much of the merino sheep: this is most abundant on the shoulder, neck, back, and thighs. The beard which hangs from the chin seems to be continued down the throat, and to dangle in the same way from the chest between the fore legs. The sexes are pretty much alike, only that in the male the horns are rather more developed, and the beard and outer coat longer. The kids are the prettiest little things imaginable; they were running with their mothers at the time I first saw them, which was early in July; so that I should imagine the period for producing their young would be somewhere about the end of May, or the beginning of June. I never saw but one female with two kids at her side; hence, I am

THE ROCKY MOUNTAIN GOAT.

Aplocerus montanus, (Richd.)

disposed to think that one kid is the usual number produced at a birth. I have often watched the little fellows at play. Choosing some rounded knoll, they seemed to go in for a game of "I keep castle." One, having possession of the summit, tried his best to beat off and keep down all besiegers, until another, taking him at a disadvantage, butted him off, and then held his right of territory, until displaced himself by some other adventurous rival. Nothing could exceed the agile, springy, elastic bounds of these little kids, as they frisked and gambolled upon the grassy sward. I do not think these goats (I shall continue to call them goats for convenience' sake) ever descend into the valleys; but when the winter snows cover up the higher zones of the mountains, they come down only to the verge of the snow line, and there somehow contrive to scrape up a scanty livelihood, until the summer's sun restores to them their favourite pasturing ground.

Few animals—I do not even except the big horn (*Ovis montana*), or the prongbuck (*Antilocapra Americana*)—are more difficult to hunt than are Rocky Mountain Goats. Tenanting, as they do, the loftiest ridges and pinnacles of the mountains, which often attain an altitude of ten or fifteen thousand feet above the sea-level, climbing after and following these goats entails upon the hunter an amount of labour and fatigue that is likely to exhaust him completely before he really begins his hunt. Moreover, the difficulties are greatly multiplied by the extreme caution and wariness of the animals themselves.

Their senses of smell and hearing are wonderfully acute, and to approach them one has to scramble up the face of nearly vertical cliffs of rock from ledge to ledge, and twist like an eel round sharp angles and ragged projections, where a slip would most likely end in being hopelessly smashed in the depths below. Getting the "wind" of the goats under such difficulties is by no means as easy a task as it is on the plains and in the wooded valleys. Hence it very often happens, when you have toiled long and wearily after a herd of goats, that they suddenly get your "wind," and are gone for ever, when, figuratively speaking, you imagined you had your hand upon them. More than once I have climbed and climbed until my arms and legs ached again, and, when my labours were nearly being crowned with success, I have, by accident, displaced a few stones, which have gone rattling down from crag to crag, a warning and danger signal by which the goats at once profited, much to my chagrin and discomfort. I did, however, obtain some fine specimens, one or two of which are

now in the British Museum, and others, as trophies, are spread out upon the floors in some of the rooms in my residence, and very admirable mats they make.

If space allowed, I could relate some very sensational adventures and escapades that I have had whilst hunting the Rocky Mountain Goat. Its flesh I do not at all admire; it has a strong, rank flavour, and is generally as tough as a moccassin; even the kid's flesh is not exempt from this disagreeable taint. Their food consists of the grasses that are commonly found at great altitudes, together with lichens, mosses, and the young fronds of the *Pinus contorta*. The mountain goat has rather an extensive range, though, so far as I know, it is only found in North and North-Western America. It is common on all the higher portions of the Northern Rocky Mountains—Cascade, Coast, and Olympian ranges. I have likewise met with it in considerable abundance upon the more elevated peaks and crests of the mountains in Washington territory. It has also been obtained near Fort Benton, and it extends its range in a northerly direction to latitude 65° N. A very favourite haunt of this goat is on Mount Rainer, one of the most lofty of the coast range of mountains. The Indians also obtain a great many from the mountains near Fort Simpson, and on the hills near Upper Nesqually.

As an article of food, the North-Western Indians care very little about the flesh of the mountain goat, and were it only valuable for edible purposes, it would be seldom sought after by the hunter; neither is its skin of any material value to the fur trader. The Hudson's Bay Company take a few of the better class of goat-skins from the Indian fur-trappers, but pay only a very meagre price for them. It is worthy of remark, *en passant*, that at the Hudson Bay Company's March sale for furs for the year 1867, Rocky Mountain Goat-skins, although of unusually fine staple, realized only about a shilling per skin, not a tenth part as much as they made in the years 1864-5; and this falling off in value is thus accounted for:—During the previous years, it was the fashion with the ladies to use muffs, tippets, etc., made from the long black hair of an African monkey. The dyed hair of the Rocky Mountain Goat exactly corresponds with that obtained from "Jacko," and as it could be purchased for a considerably smaller sum, the demand was great for it; and hence the increased price it fetched at the auction. Now monkey-skin garments are not in vogue, the goats' hair employed to imitate it is not required, and accordingly the price has receded to a mere nothing. It is not a little remarkable that the employment of this jacket of a tropical animal should have a

direct influence upon the value of one mainly confined to high northern latitudes.

To the Indians, however, the skin of the mountain goat is, or rather once was, of inestimable value. Prior to the Hudson's Bay Company establishing their trading depôts for the acquirement of furs throughout North and North-West America, the savages west of the Rocky Mountains were in the habit of making a rude description of blanket or rug from the fleece of the mountain-goat. This art, to a great extent, ceased when the English blanket was introduced by the Hudson's Bay Company, and was given in exchange for furs of different kinds. I obtained several rugs of the original manufacture whilst naturalist to the British North-American Boundary Commission, and I also procured the apparatus with which the aborigines of British Columbia and Vancouver Island spun the softer wool into yarn. I likewise got hold of the rude loom with which they afterwards wove the yarn into a rough but efficient blanket. These, together with specimens of the yarn and woven blankets, are deposited, and can be seen, in the ethnographical department of the British Museum.

In conjunction with the fleece of the goat, the hair obtained from a peculiar breed of long-haired white dog was likewise frequently employed in spinning the yarn. The hair was plucked from these wretched dogs at a particular season of the year, and the tortures they afterwards endured from the mosquitoes was something terrible to contemplate. In some of these curious blankets I obtained of native makers, duck and goose feathers are worked in with the goats' wool and dogs' hair. It seems to me that this art of weaving, which was clearly known to the aborigines long before we knew of their having had any intercourse with civilized people, opens up some extremely curious and interesting queries. Whence did those tribes of savages, living so far beyond the range of civilization, obtain their knowledge of the art of weaving? There can be no question that the North-Western American Indians were familiar with the art before we have any tradition of their having had any opportunity of learning it from civilized people. And not only the art of weaving, but the science of dyeing with different colours such materials as they employed, was also known and practised by them. I have specimens of mats and rugs, showing carefully-designed coloured patterns. Now, the first question that presents itself for consideration is, how and whence did these savages obtain the long-haired white dog? The dog is now extinct, or nearly so—its use having ceased with the introduction of English

blankets. I have tried to trace its history, and I may state what I have discovered in this article, as the hair of the dog and of the mountain-goat were jointly used in the manufacture of blankets.

This long-haired dog was possessed only by a few tribes of Indians, who inhabited the N.W. coast. The dogs were scrupulously kept on islands, in order to prevent any chance of their escaping; and I feel confident I am right in stating that these dogs differ in every specific detail from all the other breeds of dogs belonging to either the coast or inland savages. I am disposed to think that this long-haired dog was originally imported into North-Western America from Japan; and I am the more confirmed in this belief, from the statement of a friend of mine who is familiar with Japan. He tells me the Japanese have a small dog clothed with long white hair, closely analogous to the dog which was a few years ago kept and plucked by the North-West Indians for rug-making. There can be little doubt that the Japanese visited the coast of North-West America long prior to any other civilized people. Whether such visitors were accidentally wrecked, or whether they designedly landed in order to trade with the aborigines, is a matter not by any means easy to trace or determine.

Traditions are still existent amongst the savages who reside near the mouth of the Columbia River, of strangers having been once amongst them a very long time before they had ever seen Europeans; and what is yet more confirmatory of the supposition that these were Japanese people is the fact, that words clearly of Japanese origin are still employed in the jargon called "Chinook," commonly spoken along the coast. If I am right in this surmise, then I can see nothing very extraordinary in dogs having been brought on board the vessel, or in their subsequently becoming the property of the natives, who would be quite sharp enough to see that an animal with such a long, shaggy coat would be of great value to them. My idea is, that the art of weaving was imported at the same time as the dogs, and that the savages, on discovering how the hair of the dog could be made into comfortable coverings, at once sought out the mountain goat, because its hair was so exactly like that of the dog, served the same purposes on being woven, and was to be obtained in unlimited abundance.

That the dog was not indigenous I am quite positive. Endless varieties of dogs are at present called "Indian dogs"—nearly all of them, however, where the aborigines have been trading with whites, are either crosses with the native dog, or curs of various kinds, which have from time to time been imported by emigrants

or fur-traders. The animal which is called the "true Indian dog" is nothing more or less than a tamed "cayote," or prairie-wolf (*Canis latrans*), a most appropriate name, by the way, for a noisier brute does not exist.

Space forbids me to say in this article anything more about the uses and habits of the Rocky Mountain Goat, but I am quite sure it must by and by prove a most valuable animal to acclimatize, and would be admirably fitted to live upon the higher peaks of the Scotch mountains, where the ptarmigan finds a suitable home. Its wool is even finer than that of the merino sheep; and if the mountain-goat was properly acclimatized, it would scarcely fail to prove a source of profit as a wool-bearing animal. Let us, then, hope the day is not so very remote, when we shall see this dweller in the Rocky Mountains, at present so little known and appreciated, roaming over the heather-clad hills of our own "tight little island."

WOMANKIND:

IN ALL AGES OF WESTERN EUROPE.

BY THOMAS WRIGHT, F.S.A.

CHAPTER I.

WOMAN IN GAUL AND BRITAIN UNDER THE CELT AND ROMAN.

I CONFESS to being one of those who feel a difficulty in believing that intellectual humanity is the mere spontaneous development of an original and primeval savage. Nor, although there be advocates for such a theory, can I believe that a savage woman, taking the word "savage" to mean man in a state, mental and bodily, which could only fit him to be the companion of animals, ever gave origin to the gentle and loving qualities, and to those winning graces, which render dear to us the female portion of the society among which we live—in other words, that there is any natural affinity whatever, derived from however remote a period, between Beauty and the Beast. I believe that the mankind among which we live has no inherent qualities in possession of which we were not at first created, and that the greater or less outward display of them, and the form in which they have, at different periods, shown themselves, depended

entirely upon the circumstances under which man lived. Setting aside the mere question of reproduction, man and woman were created, I believe, equal—one intended to be the affectionate and cheering companion to the other, with some peculiarities, physical rather than mental, which tended to make the one dependent upon and attached to the other. It is in this sense only that we have any right to call womankind the weaker sex.

But this is a question which I am not now called upon to discuss any farther. Our own modern society has grown out of a gradual amalgamation of different divisions and subdivisions of one great race of mankind, known under their different movements by a variety of names, but especially by those larger denominations of Celts, or of Romans, or of Teutons. My task is to trace, so far as I can, the position and the influence of womankind through some of these developments. Of course, as we go far back into time, our knowledge on this subject becomes very scant, through want of historical records. The Greeks and Romans, through whom all our knowledge is derived, only knew the different people whom we consider as our earlier forefathers, and whom they called barbarians, as people whom they sometimes met as enemies, and they had little opportunity indeed for studying their domestic life. The first chapter of a work like this, therefore, must necessarily be imperfect, and can hardly be considered as anything more than an introduction to the story itself.

So far as history throws any light upon the subject, Western, like Central Europe, appears to have been gradually occupied by successive waves of population, which all spread hitherward from the East. Of the first of these we know very little, and they are of no great importance to our subject. We are ignorant even of the extent to which they had originally occupied Western Europe; they appear never to have made any great name there, and they seem to have been driven onwards and crushed by the Celts. To the Romans, when they became acquainted with Gaul, the remnant of these peoples was known by the name of Aquitanians, and they are believed to be represented in our time by that very mysterious people, the Basques. Amédée Thierry's idea seems now to be generally adopted, that the Celtic race moved westward in two great successive emigrations. The first of these emigrations belongs to a remote period, of which we cannot fix the date, any more than we can of the second, except that we can be certain that it was at no great distance from what we call, in regard to Western Europe, the historic period. The new Celts drove their predecessors before

them still further westward, until they seem to have been represented only, when the Romans came here, by a portion of the inhabitants of the western coast of Gaul, and of a part of the British Islands. The subdivisions of the race are of little importance to the present subject. We will consider them all under the general name of Celts.

Under this name, or under that of Gauls (*Galli*), they were well known, in their earlier movements in Eastern and Central Europe, to the Greek and Roman historians. Among other great exploits, they invaded Greece, overran Macedonia and Thessaly, and plundered the Temple of Delphi. They entered Asia Minor, exacted tribute from most of the Asiatic states, and actually disposed of the throne of Bithynia, and placed upon it Nicomedes the First. They overran Italy, and burnt Rome. Yet all we know of the domestic condition and manners of this extraordinary people at this early period of their history, for we are going back to the beginning of the third century before Christ, is derived from two or three detached anecdotes, which have been preserved merely because they made a strong impression upon the imaginations of the Greeks and Romans. These will be better understood by one or two preliminary remarks of a general character.

Woman's position, in the earlier ages, was certainly not that given to her by nature, but one which arose out of the primitive forms of society. The earliest form of government was that called patriarchal. When the population was not large, and scattered over the earth, each head of a family was the ruler over all the other members of the same family; and as he himself acknowledged no superior authority, except in heaven, he possessed absolute power over them, extending to life and death, with the only exception, perhaps, of his wife, for her family had, in disposing of her, reserved a certain right of interference for her protection. Of the males, one only held a marked position as the next successor to the headship; the others were mere dependents upon the head, until, by some arrangement or other, they left the family to form each a family of his own. The females of the family, the daughters of the head, were, if anything, more dependent than the males, because they were looked upon as the weaker sex; they could not create independent families of their own; they were therefore employed in domestic labours, and in supplying the clothes and other necessaries of the whole family. The father sold his daughter in marriage into another family, and disposed of her entirely at his will. Alliances between families were formed, and family hostilities arose,

which led to war on a more or less extensive scale; and, to ensure the united action of many families in one cause, a chieftain was necessary, elected, of course, by the whole. This chieftain became a king, and through him kingly power was introduced, and gradually became a permanent institution. Kingly power, in its earlier period, meant war. This great revolution, for it was a great one, affected chiefly the mass, the families in confederation, if we may so express it, and not the members of each family, for the father still preserved the same authority over his sons, and especially over his daughters. Woman, however, did not universally submit to her position. Attempts to form matrimonial alliances according to her own inclinations were continually made, and often with success, and these sometimes led to violent feuds between families or tribes. Moreover, we find her, to judge by individual cases which are the only ones we see in history, constantly aspiring towards a superior position. But of this I have more to say in a subsequent chapter.

When, as the number of the population increased, the necessity of expansion compelled races to migrate in search of new homes, and when the migratory parties must of course act under kingly power or chieftainship, the patriarchal authority became, probably, more and more diminished. When we first obtain any knowledge of the different branches of the Gallic race, they had either passed through their great migrations, or were in the midst of them.

The natural effects of migration would be to modify, in some degree, the character of the Celtic women, as they must have had to pass through continual hardships and dangers, which would impress upon them the more masculine characteristics of endurance and courage. According to Strabo (lib. iii. c. 4), the Celtic women, in common with the Scythians and Thracians, were remarkable for their courage. In the Cimbric wars of Marius, about a century before Christ, we find both Teutons and Gauls accompanied to battle by their wives and families. In the great defeat of the Cimbri and Ambrones by that general in the neighbourhood of Aquæ Sextiæ (Aix in Provence), their women, who had been left with the chariots, threw themselves among the fugitives, and, reproaching their husbands with their cowardice, attacked the victors and saved the confederate Gauls and Teutons from destruction by their valour; and in the second great victory of that war, gained, in the year following, over the Gallic invaders of Italy in the Raudian plain, near Vercelli in Piedmont, the women of the vanquished stoutly defended their chariots long after the flight of their husbands, and, when they saw that further

resistance would be in vain, and Marius had refused their petition to be allotted as slaves to the priestesses of the Italian temples, which would have saved their chastity from the outrages of the Roman soldiers, they put their children to death and then slew themselves. At a later period, during the wars of Cæsar in Gaul, at the siege of Avaricum, the Gaulish women prevented their husbands from abandoning the defence of the town, and the assistance and encouragement they gave to them contributed greatly to the defeat of the Romans. Down to the latest period of Gaulish independence, it was the custom of the women to accompany the men in their warlike expeditions.* In the insurrection of Civilis and the momentary empire of the Gauls in the latter half of the first century of the Christian era, we are told by Tacitus that that chieftain, when he marched at the head of his Gauls against the Roman legions, placed in position behind his line of battle his mother and his sisters, and the wives and children of all his soldiers, that they might be an incitement to victory and a shame to those who gave way.†

These characteristics of courage and ferocity could only belong to women who were living in the midst of war and strife; the women, in fact, of tribes in a state of migration, though perhaps we might, from a comparison of other facts, think that they were characteristic of the Gallic race more than of any other. They were those traits of character which first struck the minds of the people of a higher degree of civilization with whom they came in temporary contact in their movements, and whose writers have chronicled them rather than their domestic virtues, of which therefore we know little. Yet, if they held such a position in presence of the other sex in the battle-field, they can hardly have been the slaves of their husbands at home. The two sexes must have marched in their migrations and in their wars almost, if not quite, on a footing of equality. We learn from the Greek writer Athenæus, that the Celtic women were celebrated for their personal beauty. They had no less a reputation for their chastity; and the philosophic Plutarch, who has left us a treatise in Greek, "On the Virtues of Women," has recorded more than one touching anecdote on this subject. One of these belongs

* It is curious that during the Middle Ages the Welsh, in their hostile excursions upon the English border, appear to have been usually accompanied by their women, who, however, were less distinguished on these occasions by their courage than by their ferocity towards the wounded enemies, and by their aptitude at plunder. They were qualities derived perhaps from their Gaulish ancestors.

† Matrem suam sororesque simul omnium conjuges parvosque liberos consistere a tergo jubet, hortamenta victoriæ vel pulsis puborem.—Tacitus, "Hist." lib. iv. c. 18.

to the beginning of the second century before Christ. When the Gauls moved upon Greece and into Asia Minor at this early period, they as usual carried with them their women, and a great multitude of these remained the captives of the Romans in the great victory gained over the Tectosagi and their confederates, at Mount Olympus, by the Consul Cneius Manlius, B.C. 189. The guard of these captives was entrusted by the consul to a centurion, who possessed, in a more than ordinary degree, the vice of debauchery as well as covetousness, which then entered into the character of the soldier. Among the captives was the beautiful Chiamara, the wife of the chief of the Tectosages, who appears to have exercised the supreme command over the Gauls in this expedition. With this lady the Roman centurion became enamoured, and, after in vain attempting to prevail over her virtue by persuasions, he had recourse to violence. The centurion had acted contrary to his duty, and would have incurred punishment at the command of his own general; and, to calm the indignation of his victim, he promised to give her her liberty, but required a sum of gold amounting to the value of a talent by way of ransom. A place was appointed to which the money was to be brought, and Chiamara was allowed to choose one from the other captives to be sent to acquaint her relatives with the terms on which she was to be liberated. She chose an old slave of her husband's who chanced to be there, and the night following she was secretly conducted to the appointed place, where the money was brought in ingots of gold by two Gauls. The centurion began eagerly to weigh it, in order to assure himself that it was the full sum. While he was thus employed, Chiamara, in her own tongue, which was unknown to the centurion, ordered the two Gauls to draw their swords and slay him. She then took his head, wrapped it up in the skirt of her robe, and proceeded to join her husband; but when he approached to embrace her, Chiamara stopped, and threw down the head of the Roman before him, and then informed him what had happened. "Oh, wife," he said, in his exultation, "what a beautiful thing is fidelity!" His wife replied, "It is a still more beautiful thing to be able to say, 'No two men living will boast of having possessed me.'" This story is related by several of the Roman historians; Polybius, according to Plutarch, related, in a part of his history now lost, that he himself had an interview with this Gaulish lady at Sardis, and that he was astonished with her elevation of mind and understanding.

These examples, and many others we might quote, seem to show that chastity was one of the earliest virtues of womankind, and that,

even in the primitive ages, it was prized and insisted upon by the other sex. Some of the old writers, it is true, speak of tribes in a very low state of barbarism who lived in the utmost licence; but the old writers of this class were always on the look out for the marvellous, and those they speak of as living in this condition were people in remote parts who were only known to them by vague report. The advocates of the theory of the "save" origin of mankind represent that, among many of the lower tribes of savages, female virtue is looked upon with a very indifferent eye, and seem to consider it as one of the developments of the human race, so that it is satisfactory to find from history that the contrary feeling becomes stronger, instead of weaker, in proportion as we go back. In fact, licence in this respect seems to have been hitherto one of the developments which accompany civilization, rather than one of the vices which it extinguishes.

When the Gauls, three centuries before the birth of Christ, marched into Italy and burnt Rome, they found there a people not far superior to themselves in civilization, and boasting of the same class of heroic virtues, modified only by the circumstance that they were a people stationary in their own country, making wars to extend their power, and not a people wandering over the earth in search of war and consequent plunder. The Roman women of the earlier period possessed most of the nobler qualities of their sex in a very high degree. They were not accustomed to follow their husbands and fathers to battle, and therefore they possessed none of that fierce courage displayed by the Gauls of their sex; but they often showed, under sudden misfortune, a constancy of mind which was truly noble. We need only appeal to such examples as that of Lucretia as evidence of the purity of their minds. They were educated with care, for we know that the beautiful Virginia, the heroine of one of the most touching stories of Roman history, went to school. The Roman women of the times of the kings and of the republic appear to have possessed in a special degree the good qualities which render domestic life happy; they are represented as faithful wives and excellent mothers, gentle, modest, and sober. They were forbidden by law to drink wine. Athenæus, in speaking of this fact, with the very ungallant reflection that "it is a well-known fact that all the race of women is fond of drinking," adds a piece of information which further illustrates some traits in the domestic life of the early Roman ladies—"It is impossible," he says, "for a woman to drink wine without being detected: for, first of all, she has not the key of the cellar; and, in the next place, she is

bound to kiss her relations, and those of her husband, down to cousins, and to do this every day when she first sees them; and besides this she is forced to be on her best behaviour, as it is quite uncertain whom she may chance to meet; for if she has merely tasted wine it needs no informer, but is sure to betray itself."* In proof of the excellent domestic character of the Roman women it is only necessary to state that, although the Roman husbands had almost unlimited power of divorce, the first occasion on which it was exercised is said to have occurred no less than five hundred and twenty years after the foundation of Rome.

In course of time, the character of the Roman women became depraved, and the change, when it began, was rapid and fearful. While, on one hand, they became proud and haughty, vain and cruel, on the other they lost all their old respect for chastity and sobriety, and became remarkable chiefly for their excess of licentiousness and debauchery. This is the character which they bore when their example began to exercise an influence over the inhabitants of Western Europe, the people of Gaul and Britain. But it will be sufficient here to state this circumstance; it is not necessary to enter into particulars. That which more especially interests us is their dress, because it no doubt influenced the costumes of the conquered races and that of the middle ages.

The ever-varying change in the forms and character of female dress which constitutes the fashion in modern times, was unknown to the ancients. The different articles which composed the female costume in ancient Rome, hardly varied from the earliest period of its history till it became mediæval. It consisted generally of three garments, very simple in form. The first was the tunic (*tunica*), which was simply what we call in modern times a shift, which was made of thin (sometimes almost transparent) material, fitted rather closely to the body, and had no sleeves. Over this was drawn another garment called the *stola*, differing only in shape from the *tunica*, in having short sleeves, covering only the upper part of the arm. This was usually fastened in front by means of fibulæ and brooches, the number and richness of which were regulated by the wealth of the individual. The tunic reached a little below the knees; the *stola*, on the contrary, was very long, while it was girded so as to make a quantity of broad folds under the breast, still, however, reaching so low that it half covered the feet. It was the characteristic dress of the Roman matrons, and was forbidden by

* Athenæus, "Deipnosophistæ," lib. x. c. 58.

law to all who were not free women and of pure life. The tunica and stola constituted the ordinary dress of the Roman lady indoors;* when she went out she wore over the stola the third article of dress, the *palla*, or mantle. The palla resembled the toga of the male attire, and was put on in the same manner. It consisted of a rather long piece of cloth cut somewhat in the form of a half circle, though the curve was not exactly the segment of a circle. The wearer, in dressing with it, began by placing one end on her breast; it was then drawn over her left shoulder, round her back, under her right arm, across her breast, over her left shoulder and arm again, and the end was fastened behind. The left arm and shoulder were thus doubly covered, while the right arm was left bare. The accompanying cut, taken from one of the wall-paintings in Pompeii, represents a lady dressing herself with the palla, and will sufficiently explain itself. When on the body, it sometimes reached to the feet, but more frequently it reached a little below the middle or to the knees. This, however, was regulated entirely by the taste of the wearer, who was extremely particular in the manner in which it was adjusted, and bestowed more care and ornament upon it than upon any other article of her dress, except, perhaps, upon her *coiffure*.

PUTTING ON THE PALLA.

The Roman lady, no doubt, paid great attention to the latter. There is a beautiful picture among the wall-paintings found in Pompeii, representing ladies at their toilette, attended by servants, or slaves. At the time of which we are speaking, that when Roman manners were beginning to influence the people of Gaul and Britain, the slaves of both sexes in a Roman family of any respectability in life were very numerous; and, as in India at the present day, each was considered to have only one class of work to

* It would appear, from paintings found at Pompeii and elsewhere, that, in the privacy of home, the Roman ladies frequently retained the tunic as their only garment, and sometimes appear in a very extreme state of *négligé*.

attend to. In the Pompeian picture alluded to, one of the ladies is under the hands of the hair-dresser, who proceeds just in the same manner as the female arranges her own hair in the cut we give next. It is, no doubt, their especial province, and both she and her companion, who is adorning the lady's arm, seem to be attending to their duty with zeal. The form of *coiffure* most prevalent among the Roman ladies seems to have been the separation of the hair on each side from the top of the forehead; it was combed out, and formed into a large knot behind, which was held together by a hair-pin, on which latter was often bestowed very considerable ornamentation. A portion of the hair appears in many cases to be twisted, and carried over the top of the head; or this was sometimes replaced by an ornamental band of other material. The lady in the scene just described is seated in her simplest dress, the tunica alone, which is thrown down so as to leave the greater part of her body bare. The female represented in our second cut is in much the same costume, but she is dressing her hair with her own hands. The subject is also taken from a painting in Pompeii, as well as the cut which follows. As far as we can judge from the monuments which remain, the Roman women went commonly abroad without any covering on their heads; for, to say the least, anything like a hat or bonnet is rarely met with. There are, however, several figures among the paintings found in Pompeii in which the palla seems to be thrown over the head so as to form a cover for it, or some separate cloth

A ROMAN LADY AT HER TOILETTE.

is used for that purpose. An example of this is given in our third cut. It is interesting as being a part of the Roman costume

A ROMAN LADY'S HEAD-COVERING.

which seems to have been adopted by the people of Gaul and Britain, and was continued into the middle ages, forming, in fact, the model of the mediæval *couvrechef*.

(*To be continued.*)

THE HISTORY OF OZONE.

BY C. W. HEATON,

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THERE is good ground for believing that the true nature of the curious gas which, under the name of ozone, has excited the interest and attracted the researches of chemists for more than a quarter of a century, has at last been ascertained; for not only have we a theory which accounts satisfactorily for its formation and properties, and which is in perfect accordance with all known facts, but this theory has lately gained distinct confirmation from a direct crucial test. In many respects the history is a remarkable one, and it illustrates very strikingly the advantages and defects of the logical method by which scientific investigation is conducted. At every stage of the discovery new hypotheses have been framed, many of them on utterly insufficient data, and ever and anon the advancing tide of fact has swept them away one by one, until, at length, one has arisen which, having struck into more coherent soil—to carry out the simile—has only been cemented into greater solidity by the action of the waves. It is almost painful, in reading a chapter of scientific history like this, to note the mass of careful reasoning apparently wasted; the succession of brilliant ideas, each one set forth by its originator in full belief of its truth, but which has been superseded almost before it was known. Science marches on over fallen hypotheses, just as soldiers mount a breach on the dead bodies of their comrades.

In 1774, Priestly discovered oxygen, and the wonders of the new-found element soon attracted the study of all the chemists of Europe. Besides the systematic researches thus called forth, and which were destined to bear such noble fruit, a host of detached experiments were made, and one of these, seen by the light of subsequent knowledge, was of the highest importance. In 1785, the electrician, Van Marum, took it into his head to pass electric sparks through oxygen, probably as a mere tentative experiment to see what would happen. He found that the oxygen acquired a peculiar smell, and with it the power of acting directly on mercury. In fact, he obtained ozone; but chemical method being still young, and Van Marum, probably, no heaven-born genius, but little real knowledge was gained by the experiment. The smell was the same as was observed in the air in the neighbourhood of an electrical machine in

action, and Van Marum, therefore, contented himself with assuming that it was the natural smell of the "electrical matter." In this state the subject remained until 1840, when Professor Schönbein, of Basle, took it in hand, and soon brought to light a number of curious facts. He found that the substance could be formed by several distinct processes; that it was present in the oxygen obtained by the voltaic decomposition of water, and that it might even be produced without the agency of electricity, by the slow oxidation of phosphorus, or, in other words, that when one portion of oxygen was absorbed by phosphorus, another portion was always converted into ozone. The properties of ozone, or, more properly, of ozonized oxygen, were likewise studied by Schönbein with great care and ingenuity. By far the most remarkable of these was found to be its extraordinary oxidizing power. A great many substances which are incapable of uniting directly with oxygen, even at a high temperature, are instantly oxidized by ozone; and are not only oxidized, but are raised at once to their highest known state of oxidation. Of this phenomenon silver affords a good illustration. For the same reason ozone is a powerful bleaching and disinfecting agent, bearing, in these respects, so close a resemblance to chlorine that Schönbein at first imagined that it was a new analogue of that element. But this was disproved by the fact that the compounds obtained by the combination of ozone with other bodies were oxides, differing in no respects from the oxides obtained by ordinary means. Upon its active oxidizing power, Schönbein founded a most delicate test for ozone. It is well known that iodine forms a blue colour with starch, but that this reaction can only be obtained with *free* or uncombined iodine. Iodide of potassium may be mixed with starch without the production of any colour, and the oxygen of the air is quite powerless to decompose the iodide, but the smallest trace of ozone effects the decomposition immediately; caustic potash is formed, and the mixture becomes blue from the formation of the so-called iodide of starch. This mixture, spread on slips of paper, constitutes the "ozone test-paper" now so largely employed, and "ozonometers" are merely instruments for registering the depth of coloration produced by the exposure of one of the papers for a certain time to a certain quantity of air. The indications of the ozonometer are merely comparative, being expressed on an arbitrary scale ranging from 1 to 10. The remaining properties of ozone may be dismissed for the present in few words. It is insoluble in, and without action on, water. It is destroyed by heat—a temperature about equal to that of melting tin being sufficient to convert it

entirely into common oxygen; and finally, it is destroyed by black oxide of manganese and some other substances, which are not themselves oxidized by it.

All these, and a great number of similar facts, we owe to Schönbein, who has pursued his discovery with a perseverance and zeal which cannot be overrated. It is true that his researches have been almost entirely qualitative in their character, and that he has therefore arrived at erroneous conclusions as to the causes of the phenomena which he has studied; but this circumstance must not induce us to forget the gratitude we owe him for his very good and useful work. He stands to ozone something in the relation that Priestly stood in to oxygen, while the exact labours of Lavoisier have their parallel in those of Fremy and Becquerel, Andrews and Tait, Soret, and several other investigators.

Passing by the crude theories of the earlier workers on ozone, we find that the first step towards the true theory was made by Marignac and De la Rive, who proved that ozone contained no other element than oxygen, and consequently that it could only be some altered, or "allotropic" form of that element. In 1852 another important stage in the progress was reached by Becquerel and Fremy, who not only confirmed the conclusions of Marignac and De la Rive, but demonstrated that pure oxygen might, by the prolonged action of electricity, be converted entirely into ozone. It is true that this can only be effected when the ozone is absorbed as fast as it is produced—when, for instance, the electric sparks are passed through a tube of oxygen inverted over mercury or iodide of potassium—and that it has hitherto been found impossible to prepare ozone free from common oxygen, but the total conversion is none the less significant of the true nature of the substance. In 1856 Dr. Andrews showed conclusively that ozone was the same by whatever process it was prepared, and finally demolished the arguments by which Williamson and Baumert had sought to prove that it was a teroxide of hydrogen.

So far the investigation of ozone had been of a satisfactory character. Erroneous experiments had indeed been made, and incorrect theories had, as a matter of course, been founded upon them. But still the theories followed logically from the supposed facts, and the experiments themselves were conducted with care and honesty. But Schönbein, although he scarcely touched the quantitative methods, on which alone a theory can be safely based, ventured, in a letter to Faraday, dated June 25, 1858, to propound a new hypothesis to which he has ever since adhered, and which has never

wanted advocates, although it has been distinctly and formally disproved. He assumed the existence of two different and opposite kinds of oxygen, a negative and a positive kind. The former—the variety obtained by electricity, the oxidation of phosphorus, etc.—he continued to call ozone, the latter he distinguished as *antozone*, and he asserted that common, or neutral oxygen was formed by the union of both kinds. These hypothetical constituents of oxygen were furthermore assumed to exist in a great variety of oxides. Those which contained ozone were called *ozonides*, and among them were numbered the higher oxides of manganese, chromium and iron, and the oxides of the noble metals. The opposite class of oxides, the *antozonides*, comprised the peroxides of the metals of the alkalies and alkaline earths, the peroxide of hydrogen, and a few other substances. This elaborate hypothesis was based almost entirely upon the circumstance that when one of the so-called ozonides was mixed, under suitable conditions, with an antozonide, common oxygen was evolved, the ozone of one, according to Schönbein, combining with the antozone of the other. But without denying that Schönbein's hypothesis is capable of accounting for facts like these, we are compelled by the researches of Sir B. C. Brodie to believe that they can be explained as satisfactorily and more simply by a reference to the ordinary laws of chemical change. The recently ascertained density of ozone is, moreover, quite inconsistent with the truth of Schönbein's hypothesis, which, indeed, I should not have referred to here, but that it is still accepted by a considerable section of scientific men.

We come now to a much more important and genuine set of discoveries. In 1860 Andrews and Tait published in the "Philosophical Transactions" a paper "On the Volumetric Relations of Ozone," which must be regarded as the most important memoir upon the subject which has been produced since the original discovery by Schönbein. The authors found that, during the formation of ozone by the passage of the electric discharge through oxygen, a contraction of volume took place, and, consequently, that ozone must be heavier than oxygen. The amount of contraction was in direct proportion to the amount of ozone formed. It was greatest when the silent electrical discharge was employed, which likewise developed the greatest quantity of ozone; but in no case did it exceed one-twelfth of the original volume of the oxygen. On heating the gas, so as to destroy the ozone, the original volume was exactly restored. They then set to work to determine what further contraction of volume could be produced by the removal by mercury, or some

other absorbent, of the ozone which had previously been produced. This second contraction, they anticipated, would give the volume of the ozone which had been absorbed by the mercury; and as its weight could be easily ascertained by finding the amount that the mercury had gained, it would be easy to find the actual density of ozone. The result is a powerful example of the way in which experiment often contradicts hypothesis. *The removal of the ozone did not alter in the slightest degree the volume of the gas.* An imaginary example will make this more evident. We take:—

100 cubic inches of oxygen.

By the action of the electric discharge this is reduced to

92 cubic inches of ozonized oxygen,

which is really a mixture of ozone and oxygen. After the absorption of the ozone by mercury there remains—

92 cubic inches of oxygen.

So that the ozone appears to occupy no volume at all, and its density to be absolutely infinite. This curious experiment was repeated by the authors in several forms, but the result was always the same. They honestly expressed themselves surprised and puzzled at the phenomenon, and were very guarded in their attempts to account for it. New light, however, soon poured in. The experiments were too striking and too carefully performed to remain long unfruitful; and the very absurdity which they seemed to involve suggested to the acute mind of Dr. Odling a simple solution of the problem. To appreciate the force of this solution, it is necessary to bear in mind the theoretical conception of the nature of gases which modern investigation has enabled chemists to frame. To prevent unnecessary digression, I will state it dogmatically, giving none of the reasons which have led to its adoption, and omitting the real or apparent exceptions, which are, indeed, very few in number.

Every gas, whether elementary or compound, consists of minute particles called *molecules*. The molecules of all gases, whether elementary or compound, have an equal size, and, at the same temperature and pressure, a given volume contains always the same number of them. Hence all gases are equally affected by purely physical operations, such as increase or diminution of temperature or pressure. The differences between gases depends entirely upon the nature, or, so to speak, upon the *structure* of the molecules. The molecules are in reality aggregations or clusters of ultimate indivisible *atoms*. The nature, the number, and the arrangement of the atoms in each molecule determines its weight and its properties.

Elementary molecules contain atoms of only one kind, the number differing in different elements. Thus the molecules of mercury and some other elements contain but one atom; the molecules of hydrogen, oxygen, potassium, etc., two atoms; and the molecules of phosphorus and arsenic four atoms. The molecules of compound gases contain two or more different kinds of atoms, the total number of which may be only two, but may amount to sixty or eighty, or even more. The formulæ used by chemists are now invariably constructed so as to denote one molecule of each element or compound, each symbol denoting one atom. Thus, Hg . H^2 . O^2 . P^4., represent single molecules of mercury vapour, hydrogen, oxygen, and phosphorus vapour; and HCl . H^2O . H^3N., single molecules of hydrochloric acid, steam, and ammonia. The hypothesis is, of course, only a convenient explanation of well-known and certain facts; but even if the atomic theory were abandoned, the formulæ might still be used to express the facts.

Dr. Odling's theory of ozone may now be given in very few words. The molecule of oxygen contains two atoms, the molecule of ozone contains three; so that the formation of the latter body simply means the condensation of oxygen into two-thirds of its former volume. As the formula for oxygen is O^2, so that of ozone is O^3, and its oxidizing power is due to the ease with which each molecule loses its third atom of oxygen. On this view Andrews' and Tait's results become mere matters of course, as may easily be seen by returning to our former example.

100 cubic inches of oxygen yield 92 cubic inches of ozonized oxygen, because 8 cubic inches coalesce with 16 to form 16 cubic inches of ozone.

If the gas is heated, the original volume is restored, because the 16 cubic inches of ozone, O^3, yield 24 cubic inches of oxygen, O^2.

When the ozone is absorbed by mercury, it is really only the third atom which combines with the mercury, the 16 cubic inches of ozone therefore become 16 cubic inches of oxygen, and the volume remains unaltered.

This beautiful hypothesis, although accounting perfectly for all known facts, was yet, nevertheless, but a probability. One link was lacking in the chain of evidence, and it is just that link which M. Soret has supplied by a happily-devised experiment. He has discovered that whereas most substances only remove the third atom of oxygen from ozone, oil of turpentine is capable of absorbing *the whole molecule*. If the 92 cubic inches of ozonized oxygen in our imaginary experiment were treated with oil of turpentine in-

stead of mercury, a white cloud would be produced, and the residual oxygen would be found to occupy a volume of only 76 cubic inches. The only possible explanation here is that the 92 cubic inches consisted of 16 of ozone, O^3, and 76 of unaltered oxygen, O^3, and that the former was seized upon entire and removed in the solid form by the oil of turpentine. There can hardly be a doubt that this confirmatory experiment will settle the question, and that the nature of ozone, and the cause of its peculiar powers, will henceforth be regarded as established.

With this knowledge in their possession, and a very considerable mass of valuable information about the properties of the gas, chemists can now approach with some confidence the very difficult question of the presence and functions of ozone in the atmosphere. It will hardly be believed by some, but it is nevertheless true, that it is only within the last few months that ozone has been distinctly proved to exist in the air at all. Schönbein, in 1840, found that his test-paper became blue when exposed to the air, and hence concluded that ozone was present in it. Here was a new and easy field for scientific discovery! Test-papers were exposed in all directions, and countless observations on the amount of ozone in the air were recorded. But unfortunately a few radical errors and doubts have enshrouded these well-meant efforts, and the greater part of them are therefore worthless. Ozone is not by any means the only gas which affects the papers. Nitrous and nitric acid and chlorine, the two former of which, at any rate, are known to exist in the atmosphere, have an equal effect upon them, and sunlight alone is capable of effecting the decomposition, even when the paper is inclosed in a sealed tube. Hence, in the great majority of researches, it was quite impossible to say whether any—and, if any, how much—of the coloration was really due to ozone. Even in those experiments where most pains were taken to avoid doubt, as in the recent researches of Dr. Daubeny, some ambiguity still remained, so that the more cautious chemists hesitated to pronounce absolutely that ozone was a constituent of the atmosphere. Within the last few months, however, Dr. Andrews, to whom we were already so largely indebted, has communicated to the Royal Society some careful experiments, which seem to prove that the observed effects can only be due to ozone. The most decisive proof consists in passing the air through a moderately-heated tube, which is found to destroy all traces of its power on the test-paper.

This point also, then, seems to be settled, and it only remains to ascertain with equal exactness how the ozone is formed, the

variations in quantity to which it is subject, and its probable functions in nature. And here, unfortunately, we enter upon a region of doubt and contradiction. No absolute quantitative method has, as far as I am aware, hitherto been tried for the determination of ozone in the air, and the comparative observations which have been collected in such abundance are, as we have seen, for the most part of more than doubtful accuracy. Even the most reliable of them only establish a few facts, and are barely sufficient to warrant us in guessing at their probable cause. As to the distribution of ozone, it is certain that, as a general rule, country air contains more than town; and air which has come direct from the sea, more than that which has swept over a large tract of land. Dr. Daubeny found that at Torquay, in the winter months, ozone was present in the greatest quantity in the south-west, west, and south winds, and in the smallest in the north winds; whereas at Oxford, east wind brought most and the north-west least ozone. The experiments were, however, somewhat vitiated by the fact that the latter series was made in the summer months. Ozone is always absent from the air of an inhabited room, even when present in the surrounding atmosphere.

As to the mode in which ozone is generated in the air, we have only probabilities to guide us. There can hardly be a doubt that it is formed to some extent by the agency of lightning, and it is possible that this is the sole mode of its production. Some writers assert and some deny that it is present in the oxygen evolved by plants under the influence of light; but though such a formation is probable enough, the evidence, both for and against it, is at present inconclusive. And lastly, it is possible, though still unproved, that it may be formed during some of the processes of slow oxidation which are so common on our globe.

However it is formed, it is at least certain that ozone exists in the air, and that, though small in quantity, it must, from its extraordinary activity, have important functions to fulfil in nature. But this very certainty has, unfortunately, been a fruitful source of wild assumptions and mere speculative guesses, doing infinite harm to the progress of true knowledge. Some have asserted, and have attempted to prove by perfectly inconclusive reasoning, that ozone arrests infection, and destroys the germs of epidemic disease. It is highly probable that such is the case, and it is certain that its presence is incompatible with that of many noxious gases. But then it is *not* certain that epidemics are due to noxious gases, and if, as is more likely, they are propagated by spores, we have yet to

prove that the minute trace of ozone in the air is capable of destroying those spores. We can no more assume it than we could assume that it killed birds. Even more vague, and much more improbable, is the floating notion that an excess of ozone in the air "does us good." Men talk of running down to the seaside "to get a little more ozone," just as if it were not possible that the little more ozone might do them harm instead of good when they got it. In large quantity it is certainly an intensely powerful irritant poison, and that it is useful in small quantities is the merest assumption. As to the notion of its assisting the process of blood-oxidation, the probability is all the other way, for its energy would be much more likely to cause it to oxidize, and destroy the lung itself, than to permit it to pass quietly into the blood, and effect the work performed by the more gentle oxygen. The simple fact is, that we know next to nothing about this branch of the subject; and if, instead of guessing at random, we were to set to work to try to elucidate some of the obscurities by which it is surrounded, or, at any rate, were to wait until others had done it for us, we should act a much more sensible and modest part.

For the future, there is every hope. The main elements of the inquiry have already been acquired, and a strong body of experimenters are at work upon it. The British Association has appointed a committee to investigate some of the moot points, and from the high eminence of every member of it, we may justly anticipate some important contributions to our knowledge.

THE MICROSCOPE IN EDUCATION.

On all hands the active members of society by whose agency its course is determined in this country, are busied with the great question of national education. Difficulties that a few years ago were practically insurmountable are rapidly giving way under combined attack; parties who were hostile have agreed to coalesce, theological antagonisms are remitted to more appropriate questions, and the field for successful exertion, if not actually clear, is becoming so with a rapidity that is characteristic of the age of railways, telegraphs, and a free press. The highest class of thinkers demand education that it may fulfil its noblest purpose of developing men and women into the highest types of which their nature, under existing conditions, is capable; while more materialistic, and less philosophical minds wish for its prompt diffusion, chiefly that we may more effectually compete with foreign manufacturers in the career of skilled production and in the race for wealth—a thing good and necessary in its way. Others again, with an eye to political interests, and the bearings of democratic change, consider that national safety depends on national instruction, and they believe that as the number of those who contribute to make that irresistible force called "public opinion," is rapidly increasing by the admission as actors in the process of large classes formerly excluded, it is absolutely essential that the new comers should be qualified for the functions they have to perform.

The education of the working classes specially occupies the minds of many social reformers, and others devote themselves more particularly to improve middle-class schools, colleges, and universities, and thus throughout society there is an educational ferment working with a vigour and at a pace entirely unprecedented in this country.

If we look to the character of the education demanded, we cannot but notice an increasing preference for a knowledge of things, or of facts, and especially of such as belong to the domain of physical and natural science, and which, therefore, come into incessant contact with the duties, the requirements, and the convenience of daily life. A strong reaction is taking place against the purely literary training which has hitherto been held sufficient in many of our chief schools; modern languages are pitted against ancient tongues, physics are thrown at nonsense verses, and chemistry voted of more consequence than formal logic or metaphysical

disquisition. The tendencies of society, whether of action or reaction, are seldom entirely wise; but the most judicious course is to accept, and be thankful for, such a grand motive power as outbursts of national aspiration furnish, and to utilize it to the largest possible extent. Just now, the claims of science are becoming paramount, but there need be no fear of overcultivating the scientific faculties, as there is no ground for supposing that other portions of human nature are going to be buried under piles of fact. The more advanced sciences cannot be efficiently taught, except in such a way as to make them instruments of mental discipline. A manufacturer may wish his boy to learn chemistry, simply with a view to his dyeing cotton or silk, but if it is attempted to teach him the science only in its applied form, the fallacy and absurdity of the process will soon appear. Sciences must be taught for their own sake, and the truth that is in them duly brought out; or it will be found that the teaching will fail, when tested economically, quite as much as it obviously must fail when tried by the higher standard of its capacity to promote mental growth.

We have in this country no well educated *classes*, though in various classes we are fortunate enough to possess many well educated individuals who would be immensely more useful if those about them were in a better condition to receive the impulse they are competent to give towards a more reasonable, and consequently a more happy method of life than usually prevails.

Assuming that scientific instruction is to form an essential portion of the education of the future, the possession of at least a moderate quantity of philosophical apparatus will be regarded as necessary by all families raised sufficiently above want to afford its purchase, and the most popular and available instrument is assuredly a *microscope*, from the range of information it is able to impart, and from the continuous pleasure so easily procurable from its use.

In the selection of such an instrument regard of course must be had to the state of the intended purchasers' pocket; but it may save loss of money and vexation of spirit, if we caution those who are about to enter upon microscopic pursuits, not to imagine that the lowest priced instruments can possibly prove satisfactory. A microscope that will not show all ordinary objects *well*, bringing out their beauty, as well as their structure, will soon be voted a tiresome and unsatisfactory machine. Only advanced students can make any good use of the refinements of the most costly instruments, and of the most elaborate apparatus, but if only three or four pounds is given for a microscope with a couple of powers, a bull's-eye

condenser, and a few *et ceteras*, it will infallibly be found insufficient and inconvenient within six months of its acquisition, if it is kept in constant use. A mechanical stage is a luxury, not a necessity, and many pieces of apparatus may be dispensed with, if their purchase is inconvenient, without much harm; a multiplicity of powers, though handy, is not essential; but certain things should be considered prime requisites, and no instrument without them should be purchased, if the cost of a better can be afforded. As presents for schoolboys to practise upon, cheap and poor microscopes may do very well, but for any better purpose we should consider the following things necessary. First, the instrument must be steady, and whatever motions it may have must be reasonably smooth. The great makers bestow upon their first-class stands a quantity of skilled labour that of necessity makes a large addition to the price, but if the student desires a cheaper instrument he should look out for one in which the main movement of the coarse adjustment is fairly made, and upon a sound principle. Many cheap microscopes are so constructed that when the great screws are worked to bring the body up or down, they must *wabble* and jerk, defects which will get worse and worse the more the things are used. The fine adjustment should be tested in the same way. If it makes the object appear to move about on the stage, it will be a perpetual plague. In bad microscopes it is common to find the stage pierced with a little round hole the size of a shilling or a halfpenny, over which the object is placed. Such limited apertures are very inconvenient, as they interfere with the use of illuminating apparatus.

In the choice of an instrument, the inquiry should be made whether it will conveniently carry such apparatus as a spot lens, parabolic illuminator, achromatic condenser; and if not, it is better to reject it, provided the price of a superior stand can be afforded.

In the purchase of powers, a couple of good ones is better than half a dozen bad. Low powers, such as Ross's 4-inch, will give great pleasure and amusement. With only a small sum to spend, second-class low powers may be tolerated, but in the selection of $\frac{1}{4}$-inch power or upwards, the *best* should be obtained. A fine quarter by one of our great makers, with additional eye-pieces, is better and more useful than a set of high powers of an inferior kind.

Families should not too readily grudge the price of a good instrument, as it will last their lives; and it is not a little barbarous and absurd to find costly finery in a house destitute of appliances for the cultivation of the mind.

Let us suppose a microscope bought—what is so be done with

it? Here we fall back upon the tendency of the times towards scientific education. Every one ought, for example, to know some at least of the elementary truths of anatomy and physiology. Foolish people fancy that such matters are only fit for those who may be destined for medical pursuits; but every one is interested in the preservation of health, and it is absurd that society should bring up men and women entirely ignorant of the nature of the human frame. Even a baby may be regarded as a complicated piece of philosophical apparatus which it is folly to commit to the charge of a *curator* who has not the remotest idea of *how it goes*.

With the aid of a microscope, and a few well-selected preparations, sound elementary knowledge of the nature of bones, muscles, nerves, lungs, skin, etc., may be easily and very agreeably obtained, and the ideas thus communicated will not only enlarge the mind, but furnish useful hints for practical conduct all through life. It will be found that when objects of the kind referred to are seen, books relating to them will become interesting, although they might prove most wearisome to plod through without such aid.

When once the simpler elements of physiology have been mastered, a multiplicity of objects in the lower ranks of organic life become of great interest. Portions of insects, exemplifying the means by which they are enabled to do something like what man does with a different apparatus, in the way of locomotion, food catching, digestion, etc., rise in value as objects of study or amusement just in proportion to the range of physical or physiological knowledge previously acquired.

It will be conceded by all acquainted with the matter, that a course of microscopic instruction of the kind indicated should be regarded as an indispensable feature in every civilized educational scheme.

Passing from the animal to the vegetable kingdom, a great deal of important information furnishing food for reflection may be obtained, by directing the microscope to readily accessible plants. Those who do not intend to study botany as a science, ought yet to know the appearance and functions of the principal organs by which plant-life is carried on. Stamens, pistils, pollen, vessels of different descriptions, seeds, tissues, and cells of plants, ought to be familiar things to all who have any pretence to education, and though mere reading about may be perplexing and wearisome, seeing them properly exhibited under the microscope rarely fails to instruct and delight.

The vegetable world offers an endless succession of beautiful

microscopic objects, and their dissection involves no unpleasant processes or disagreeable tasks. To know plants only as they appear to the unassisted eye, is to have but a slight and feeble acquaintance with their larger varieties only, for multitudes of the most exquisite forms of vegetation can only be seen by the microscope's aid. In the green slime or scum upon stones or ponds, in moulds, mildews, etc., what elegant shapes and charming tints appear; and what astonishment seizes the mind when the eye first sees undoubted plants move about and change their shapes like the Euglenæ, as if stimulated by a purpose and impelled by a will.

If the microscope is used simply as a plaything, it soon meets with the fate of other playthings, in being thrown aside. More rationally employed, it provides a constant stimulus to inquiry. The observer finds his curiosity excited first in one direction and then in another. To explain one thing he wants to know a little chemistry, to understand another a little physiology, and so forth from day to day.

When the microscope is merely made to serve the purpose of an elegant amusement, it is by no means to be despised, nor ought those who so employ it to be ridiculed for their taste. Looked at from a recreational point of view, microscopy is well worth taking up, though we certainly advise its employment in a more studious spirit, and in a systematic way. Indeed, the more it has been used for study, the more it may be used for amusement, because the observer, who has acquired an extensive range of information, will be much better qualified to develope its recreational capacities than can possibly be effected by a comparatively uninstructed practitioner.

Fresh objects will, as a rule, be more interesting than slides, and living ones are preferable to dead: but there are many things, such as details of structure, that can only be seen in well-made preparations; and any one who buys a microscope should learn how to prepare all ordinary slides, for which abundant instructions are given in well-known works.

In families much interest is easily excited by illustrations of the structure of ordinary things in regular use, and but little skill is required to make thin slices, sections, and other preparations necessary for their display. A little practice will easily lead to the discovery of the powers and modes of illumination best employed. It is best to begin with the lower powers, and, though an object may be transparent enough for transmitted illumination, it is often worth trying it also by reflected light. Bodies, again, that are

opaque in a mass become translucent in their sections, and many which present no beauty with ordinary illumination become splendid with polarized light.

We shall, from time to time, furnish beginners with information which will assist them in microscopic pursuits; and when papers refer to subjects that may at first sight seem a little beyond their reach, they will frequently find that the difficulty may be made to vanish with much less trouble than they suppose.

Without any prejudice in favour of particular pursuits or peculiar methods of instruction, we feel bound to give a preference to plans which bring truths home to the eye, and with this view it is impossible not to regard the microscope as one of the foremost instruments for the communication of knowledge, equally adapted to class teaching and to private study. No better investment can be made than in a good microscope, a binocular one being preferable. A bad instrument or bungling manipulation will, no doubt, do damage to the sight; but a good one, properly arranged, will show small objects as plainly and as comfortably as larger ones can be seen with the unassisted eye.

As a general guide to purchasers, we may say that microscopes below £5 in price are not likely to satisfy any one who acquires moderate skill in the use of such an instrument. From £5 to £10 a much more generally useful instrument may be obtained. From £10 to £20 a good binocular stand, with a couple of powers and several pieces of apparatus, may be purchased. A considerable improvement in quality of the brass-work and movements, with more apparatus, will require an outlay from £20 to £30; while those who can afford it should have the very best, at from £50 to £100, which need not be spent all at once, unless the purchaser is quite sure what he will want.

METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

BY G. M. WHIPPLE.

(*With a Plate.*)

OCTOBER, 1867.

INSTEAD of our usual tabulated observations, we shall henceforth give the observations in the form of curves of monthly atmospheric variations.

In the diagrams the upper figure represents the movement of the barometer from day to day, derived by connecting the points marking the mean daily pressure.

Below the barometer curve we have the curve of maximum daily temperature, next the mean temperature of the day, and then the minimum temperature of the same day.

The lowest curve is that of relative humidity. Here increasing ordinates, or a rising of the curve, denotes increasing dryness of the air, complete saturation being represented as 1·00.

The rainfall is shown by the vertical lines at the bottom of the diagram, which indicate, by their length, the depth of rain fallen in the twenty-four hours between 10 A.M. of the preceding day and 10 A.M. of the day on which it is marked.

ATMOSPHERIC PRESSURE.—The month commenced with a high barometer; on the 1st it stood at 30·421; it then fell gradually, with the exception of a slight rise on the 4th, till it reached 29·590. An upward movement followed to the 11th. A fall again took place on the 12th and 13th, and the barometer remained low until the 19th, when it read 29·691. The readings then increased up to 30·217 on the 22nd; after which a fall occurred to 29·875 on the 24th; it rose on the 25th to 30·160, afterwards falling rapidly; on the 27th it reached the lowest point in the month, 29·382; rising on the 28th, and a little on the 30th, read 29·937 on the 31st.

The times of greatest movement of the barometer were, a great fall from 1d. 5h. P.M. to 2d. 6h. P.M., and a rapid fall from 9d. 3h. P.M. to midnight, followed by a rise to midnight on the 10th; there was also a rapid fall from 26d. 10 A.M., to 27th, noon; then a sudden rise, followed by a more gradual rise through 28th; after that it gradually fell.

The mean barometric pressure for the month was 29·911 inches.

TEMPERATURE.—Similar to the barometer, the thermometer fell

at the commencement of the month, from 50·2° on the 1st, to 42·0° on the 4th. The mean temperature remained at nearly the same point till the 11th, when it began to increase, reaching 57·4° on the 15th; it fell the next few days, but rose again the 22nd, when the highest mean temperature of the month, 58·3°, was attained. The only noticeable change after this date was a low temperature of 43·9° on the 28th, followed by a rise to 55·2° on the 29th.

The highest maxima occurred on the 15th, 17th, and 22nd, the thermometer on those days recording 63·2°, 62·4°, and 64·6°; the lowest maxima were the 4th, 48·3°; 9th, 47·9°; and the 11th, 47·1°.

The lowest minima recorded were the 6th, 30·2°, and the 11th, 30·0°. The highest minima were those read on the 22nd, 52·7°; 23rd, 54·1°; and the 31st, 52·9°.

The days on which the greatest daily range of temperature occurred were the 14th, 23·4°; and the 6th and 21st, 23.0°.

The least ranges were, 23rd, 6·9°; 30th, 5·2°; and 31st, 4·8°.

The most noticeable features of the thermograph records for the month were a sudden fall of 5°, which happened at 8d., 2 P.M., and an almost instantaneous decrease of 10° recorded at 12.50 P.M. on the 27th, at the same time that the barometer reached its minimum, and suddenly rose.

Between 11th, 6 P.M., and 12th, 8 A.M., the thermometer did not vary 1°.

The mean monthly temperature was 50·0°.

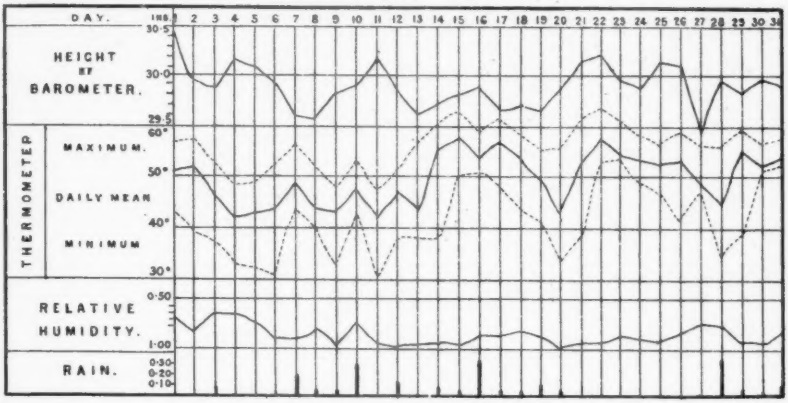
Relative Humidity.—The days on which the amount of aqueous vapour present in the air was least, were the 1st, 3rd, 4th, 5th, 27th, and 28th, when it was ·63, ·65, ·67, ·70, ·77, and ·74, respectively; complete saturation being 1·00. The days of greatest humidity were the 11th, ·96; 12th, ·97; 13th, ·96; and 20th, ·99.

Rainfall.—Rain was recorded as follows:—

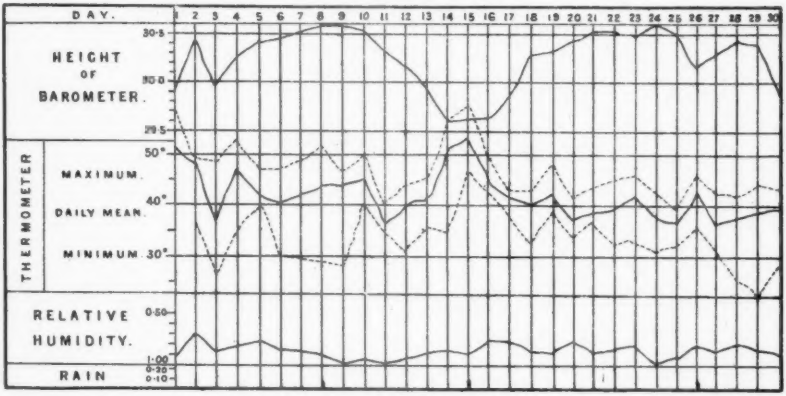
DAY.	AMOUNT.	DAY.	AMOUNT.	DAY.	AMOUNT.
3.....	0·040 inch.	14.....	0·030 inch.	20.....	0·005 inch.
7.....	·172 „	15.....	·004 „	28.....	·340 „
8.....	·010 „	16.....	·353 „	29.....	·023 „
9.....	·005 „	17.....	·010 „	30.....	·014 „
10.....	·280 „	18.....	·030 „	31.....	·066 „
12.....	·153 „	19.....	·080 „		

DIAGRAMS, REPRESENTING THE METEROLOGICAL VARIATIONS AT THE KEW OBSERVATORY.

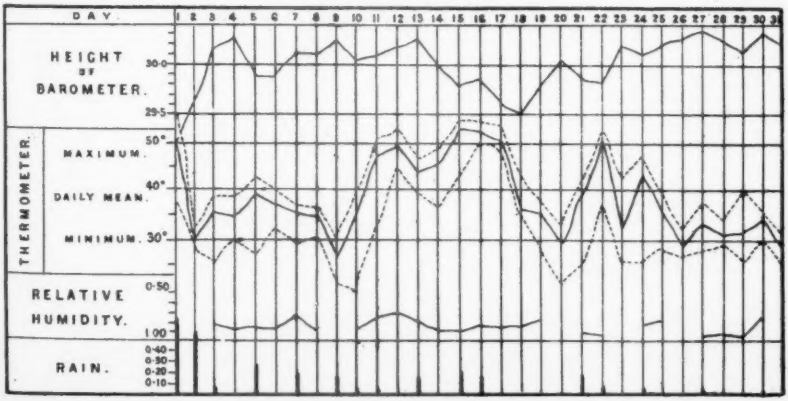
OCTOBER, 1867.



NOVEMBER, 1867.



DECEMBER, 1867.



The total amount of rain fallen in the month=1·615 inch.
The velocity of the wind was not recorded throughout October.
The principal direction of the wind was—
South-Westerly—2nd, 9th, 16th, 17th, 18th, 19th, 21st, 22nd, 26th, 29th, and 31st.
North-Westerly—3rd, 4th, 5th, 8th, and 28th.
Northerly—10th.
North-Easterly—25th.
South-Easterly—14th, 15th, 23rd, and 24th.
The wind being very light on the remaining days.

November, 1867.

Atmospheric Pressure.—The fluctuations in the height of the barometric column were not so numerous as in the previous month, but extended over a greater length of scale.

The mean height on the 1st was 29·937, differing but slightly from the last observation of the preceding month. About 2 P.M. it commenced to rise, and continuing through the night, read 30·428 the next day. A fall then occurred to 29·959 on the 3rd; after which a very gradual rise ensued up to the 9th, when the reading was 30·593. From this point the readings steadily diminished to 29·601 on the 14th. It remained about the same height through the 15th and 16th; then rose during the 17th and 18th to 30·292. The rise that followed was slower until the maximum reading of the month, 30·646, was recorded on the 24th. During the next two days the barometer went down; afterwards slightly rising, fell on the 30th to 29·894.

The mean height for the month was 30·284 in.

Temperature of the Air.—The curve of mean temperature is not so regular as the barometer curve.

The temperature of the 1st was 51·1°; it fell then very much until the 3rd, when it stood at 35·7°. Between 8 A.M. and noon of that day there was a rapid rise, and the next day the mean was 48·0°. The thermometer was nearly stationary up to the 10th, when it fell, and read 36·3° on the 11th. After this the temperature increased gradually to the 15th, the warmest day in the month, the mean for that day being 53·9°. A decline followed to 37·0° on the 20th, and cold days continued to the 25th. The 26th was warmer, the temperature being 43·1°. The next day was the coldest day during the month; the mean was 35·6°. The thermometer rose slightly the succeeding days, and read 39·2° on the 30th.

The highest maximum temperatures recorded were 60·9° on the

1st, 55·6° on the 14th, and 60·0° on the 15th. The lowest maxima were—11th, 40·1°; 20th, 40·5°; and the 25th, 39·7°.

The minimum thermometer read lowest on the 28th and 29th, when it stood at 25·0° and 22·6°. It recorded 25·9° on the 3rd.

The highest minimum was 47·4° on the 15th. The extent of daily range was greatest on the 3rd, 22·4°; 8th, 22·5°; 14th, 20·6°; and 29th, 21·1°. The variation was least the 11th, 4·5°, and 17th, 4·6°.

At 2 P.M. on the 1st, a sudden fall occurred in the temperature of 7°.

The mean temperature for the month was 41·9°.

RELATIVE HUMIDITY.—The driest days were the 2nd, 5th, and 20th, when the proportion of aqueous vapour was ·65, ·75, and ·72. The mean amount of moisture was exceeded on the 9th, 11th, and 24th, on each of which occasions it was ·99, complete saturation being 1·00.

RAINFALL.—Scarcely any rain fell during November, the only recorded quantities were—

2nd, 0·003.	15th, 0·060.
8th, 0·004.	26th, 0·008.

Giving for the month the total of 0·075 in.

DIRECTION OF WIND.—

North, 2nd, 6th, 18th, 23rd.

North-west, 1st, 19th, 20th, 21st, and 22nd.

West, 4th, 8th, 26th, and 28th.

South-west, 3rd, 25th, 29th, and 30th.

South, 14th, and North-east, 5th, 15th, 16th, 17th, and 24th.

The velocity was not recorded continuously,

DECEMBER, 1867.

ATMOSPHERIC PRESSURE.—The last month closed with the barometer falling. It continued rapidly doing so up till 6.30 P.M. on the 1st, when it reached the unusually low point 28·740 inches; after which it rose as quickly as it fell, giving a mean height, on the 1st, of 29·252.

The readings continued increasing up to the 4th, it being then 30·311; the next day it fell to 29·829, remaining stationary to the 6th; then rose steadily to 30·274 on the 9th. The pressure diminished slightly on the 10th, but augmented gradually to the same point on the 13th; then a regular fall set in, which continued up to the 18th, it having descended to 29·510 at that date.

A rise, somewhat interrupted, succeeded, to the maximum height of the month, 30·371, which was attained on the 27th. After this

date the barometer continued high to the end of the month, a slight fall on the 29th alone intervening.

The mean reading of the barometer for the month of December was 30·014 inches.

Temperature of the Air.—The fluctuations of the thermometer were numerous, and of considerable extent, during the month.

On the 1st the temperature was nearly constant at 54° until 6.30 P.M. At this time, when also the barometer arrived at its lowest point, the thermometer fell suddenly about 5°, and then a rapid continuous fall set in up till 8 A.M. the next day, having reached 28·0; it remained low the whole of that day, the mean being 29·2. The succeeding days were a little warmer, the temperature on the 5th being 38·5; but after this the thermometer gradually went down to 26·5 on the 9th, the coldest day in the month. But a great rise occurred after, it running up to 49·1 on the 12th; falling a little on the 13th, it again rose, and the 15th was the warmest day of the month, the mean being 51·9. At 2·10 P.M. on the 18th, an almost sudden fall of 5° was recorded, and then the temperature went down and read 29·0 on the 20th. It went up again to 50·2 on the 22nd. At 1 P.M. a continuous fall set in, which lasted till 10 A.M. on the 24th, when it was 30·0. It quickly rose to 45·0 at 2 P.M., and remained stationary at that point till noon the next day.

The 26th was another cold day, the mean being 29·3; and the temperature continued low to the end of the month.

The highest maximum readings were 55·1 on the 1st, and 53·7 on the 15th and 16th. The lowest were 31·7 on the 2nd, 30·2 on the 9th, and 31·2 on the 31st.

The lowest minima recorded were on the 0th, 10th, and 20th, these being 21·6, 19·8, and 22·0 respectively. The highest minima were—16th, 49·7; and 17th, 28·1.

Daily Range.—This was greatest on the 24th, when it was 22·5. On the 10th it was 19·0. The extent of range was least on the 2nd, 3·7°, and 16th, 4·0°.

The mean temperature for the month, was 38·3°.

Relative Humidity.—This record for the month is very imperfect, good determinations not having been obtained on several of the days. Of those when it was observed, the 7th, 12th, and 30th were the most dry, being ·76, ·75, and ·77.

The greatest amount of moisture was present on the 22nd and 28th, being ·98 on those days.

Rainfall.—Several of the recorded amounts fell as snow, and

were melted previous to being measured. Such are marked *. The quantities were as follows:—

DAY.	AMOUNT.	DAY.	AMOUNT.	DAY.	AMOUNT.	DAY.	AMOUNT.
1...	0·686 inch.	6...	0·010* inch.	15...	0·130 inch.	22...	0·040 inch.
2...	·523* „	7...	·014* „	16...	·105 „	24...	·013 „
3...	·005* „	8 & 9.	·126* „	18...	·005 „	27...	·010 „
5...	·185 „	11...	·005 „	21...	·118 „	30...	·004 „

The total fall during the month being 1·979 inches.

DIRECTION OF WIND.—

Northerly—7th, 9th, 25th, and 29th.

North-West—2nd, 3rd, 5th, 6th, 8th, 11th, 12th, 13th, 15th, 18th, 19th, and 22nd.

West—16th, 17th, 20th.

South-West—1st, 10th, 14th, 21st, 23rd, and 26th.

South—24th.

East—31st.

North-East—27th, 28th, and 30th.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

MONTHLY AND ANNUAL MEANS FOR THE YEAR 1867.

Month.	Barometer, corrected to temp. 32°.	Temperature of Air.	Dew Point.	Relative Humidity.	Daily Range.	Total Fall of Rain.
	inches.	°	°		°	inches.
January	29·649	34·8	(35·8)	·86	12·0	3·373
February	30·030	44·9	39·2	·82	9·9	1·253
March	29·740	37·0	32·0	·83	11·2	1·980
April	29·812	48·5	42·2	·81	14·2	1·625
May	29·899	52·9	43·8	·74	17·6	1·285
June	30·043	57·3	50·2	·80	18·7	1·361
July	29·894	59·6	51·2	·75	17·7	3·606
August	29·584	62·0	53·8	·76	18·0	2·057
September	30·371	56·9	49·8	·79	15·0	2·263
October	29·911	50·0	45·5	·85	14·7	1·615
November	30·284	41·9	37·3	·85	12·4	0·075
December	30·014	38·3	36·8	·88	10·3	1·979
Yearly Means	29·911	48·7	43·1	·81	14·3	22·472

Highest Temperature recorded during the Year..... 85·9° on August 14th.
Lowest ditto ditto ditto ..... 1·0° on January 5th.
Greatest Fall of Rain in twenty-four hours..... 1·328 inch on July 25th.

ASTRONOMICAL NOTES FOR FEBRUARY.

BY W. T. LYNN, B.A., F.R.A.S.

Of the Royal Observatory, Greenwich.

It is no less pleasing than profitable, in our progress up the ascent of science, sometimes to pause and contemplate the appearance presented by the stand-point at which we have arrived, thereby invigorating ourselves by the prospect of the results already achieved, and deriving well-founded hope for the triumphs yet awaiting the labours of the patient and intellectual observer of the facts of nature. Perhaps this is at least as much the case in the science of astronomy, the oldest and most perfect of them all, as in any other. There is a tendency to imagine that when a vast body of facts has been so formed, as it has here, into a coherent whole, that the mutual support of each part—according to the well-known remark of Bacon—gives an enduring strength to the theory containing all, there no longer remains anything to be accomplished, save to fill in some minor details, and to discover some less important residual phenomena. The truth appears to be better represented by the analogy of the erection of a firm and solid foundation, which enables us fearlessly to add a higher and higher superstructure, and, also, availing ourselves of other firm foundations when they lie at hand, or are afterwards acquired, in the shape of well-established theories in other sciences, to erect, upon a united basis, still nobler and more extensive edifices. Of course it follows that the broader and larger is our foundation, the more material will be required for the superstructure. Hence does it arise that as science advances, she more and more eagerly welcomes a larger and ever-increasing accession of workers into her ranks, and provided they be really earnest students of nature, and careful observers of facts, has abundance of well-repaying employment for all who are able to enlist themselves in any degree into her service.

When Heis, Quetelet, Glaisher, Greg, and a few others, some years ago, commenced laboriously recording the places and paths of all the meteors of which they were able to obtain observations, who could have anticipated that physical astronomy would be able, in 1866-7, to apply the resources of mathematical analysis to these

wayward bodies, and to show that at least one group of them, obeyed the laws of planetary motion, and appeared periodically in consequence of its motion round a very eccentric ellipse? No time was left us to speculate on the mere analogy here presented with the motions of comets; we were startled at the same time to learn that the path of this group was nearly if not quite identical with that of a small comet. Thereby new conjectures were immediately suggested, and zest is given for further and still more assiduous observation of all kinds of meteors. The coincidence, if it be only coincidence, has been also shown in two other groups of meteors, and it is to be hoped that this year will enable us to acquire some new facts connected with this interesting subject.

When Wollaston, more than half a century ago, noticed dark bands in the solar spectrum, who could have dreamed that the remark was the forerunner of those wonderful discoveries so recently obtained concerning the actual chemical constitution of not only the Sun, but even of the more distant fixed stars, and still more distant nebulæ? The labours of Mr. Huggins lead us to hope that some light may be thrown in this way upon what we should think of such strange speculations as the nebular hypothesis. Well may we hope that the year 1868 will not be barren of results in this subject also.

The year 1866 was remarkable for the rare phenomenon of the sudden outburst of a star, which, previously quite telescopic, became distinctly visible to the naked eye; so much so as to completely change the apparent shape of the constellation, Corona, in which it was situated. It will be desirable to keep a look-out upon this star, with the view of ascertaining whether it undergoes any further changes. Its place is R.A., 15h. 54m. 0s., N.P.D. 63° 42′; whilst that of ϵ Coronæ, the bright star near it, is R.A. 15h. 52m. 7s., N.P.D., 62° 44′. Some other discoveries of a like, but less startling kind, made by Julius Schmidt, the indefatigable Director of the Observatory at Athens, have afforded additional proof that naked-eye astronomical observations are still sometimes productive of good fruit.

Although much more might be said of the future prospects of astronomy, both in reference to matters which, now but mere conjectures, may, in accordance with previous analogy, become ere long ascertained facts, and in reference to what may be hoped for from the laborious exertions of established observatories, which are even now enlarging our knowledge of parts of the universe beyond our own solar system, yet we must rather pass on to the more

immediate subject of the present paper—the suggestion of suitable objects for general observation in the month of February, 1868.

PLANETS OF THE MONTH.—SATURN will be a beautiful object in the early morning hours, but will, throughout the month, not rise until considerably after midnight. About half an hour before rising on the morning of the 16th (that is, at twenty-three minutes before two o'clock), it will be in conjunction with the Moon.

JUPITER will be visible in the early evening, but low in the heavens, so that scarcely any of the phenomena of his satellites will be seen, and none possessed of any particular interest. In the latter half of the month he will set soon after six o'clock.

MERCURY will be tolerably well situated for observation, as he will be at his greatest elongation on February 20; and, as he will then be approaching inferior conjunction, he will afterwards appear horned. At the beginning of the month he will set about half-past five, at the end of it not till nearly half-past seven. On the 24th and 25th he will be very near the Moon, being in conjunction with her about midnight on the former day.

This planet is seldom seen with the unassisted eye, from its being only visible at certain times, and then usually very near the horizon. Yet it shines with an intense light, and bright white colour, and is at times, between greatest elongation and inferior conjunction, very conspicuous. Indeed, in large telescopes (as is also the case with Venus), when seen after sunset, it is requisite, in order to obtain good definition to observe with a slightly coloured glass, to take off the glare of the light. It reflects great credit upon the diligence of the ancient Greek astronomers that they observed this planet so frequently as they did. Riccioli made use of the expression, that the celestial Mercury was as slippery a customer for astronomers as the terrestrial mercury (quicksilver) for chemists and alchemists. And it is well known that the great Copernicus regretted on his death-bed, that, notwithstanding all his efforts, he had never once succeeded in seeing it.

It is somewhat singular that nearly all our knowledge of this body is derived from the observations of Schröter, at the beginning of the present century. He, and his assistant Harding, noticed changes in the brightness of particular parts of the surface, which were probably due to variations in the clouds upon it, and therefore indicated the existence of an atmosphere, the possible means of tempering the intense glare of the sunshine. A periodical blunting or thickening of the southern horn appeared to suggest the presence of mountains, of a height which they estimated at nearly eleven

miles, and afforded a means of estimating the time of the planet's rotation on its axis, which they considered to be about 24h. 5½m. It would be extremely desirable to obtain some confirmation of these results. But few persons have courage or patience to attempt it.

VENUS is gibbous throughout the month. At the beginning of it she sets about a quarter to eight; at the end, a little before nine. At a quarter past four on the afternoon of the 26th, she is in conjunction with the Moon, and is then only 3° 11′ north of that body.

Venus is, to use Sir John Herschel's expression, the most difficult of all the planets to define with a telescope. The existence of an atmosphere nearly equal to our own in density and height has been clearly proved. An alteration in the appearance of the south horn, similar to that of Mercury's, has been noticed. The time of rotation has been formerly a matter of dispute, but Schröter, by long and patient observations, was able to trace the motions of spots, which gave a time of about 23h. 21m. This has been well confirmed by the observations of De Vico at Rome, who, observing these spots in the day-time, was led to a time which may be supposed pretty exact. It amounts to 23h. 21m. 23s. These spots are extremely difficult to see, yet, in peculiarly favourable conditions of our own atmosphere, may sometimes be much less so; so that, as is observed by the Rev. T. W. Webb, in that invaluable book for amateurs, "Celestial Objects for Common Telescopes," "the possessors of even common telescopes need not despair, though their chances may not be great." The appearances of the southern horn already mentioned have been supposed to prove the existence of mountains of a height very considerably exceeding that of the highest elevations on the earth.

OCCULTATIONS OF STARS BY THE MOON are often very interesting phenomena. We annex a table of those which will be visible during the month before one o'clock in the morning. They are five in number, as follows; M. denoting the magnitude of the star, and V. the angle from the highest point, or vertex, of the Moon, counting round to the right hand in an inverting telescope, at which the disappearance and reappearance respectively take place.

OCCULTATIONS OF STARS BY THE MOON.

DAY.	NAME OF STAR.	M.	DISAPPEARANCE.		REAPPEARANCE.	
			MEAN TIME.	V.	MEAN TIME.	V.
			h. m.	°	h. m.	°
Feb. 4	130 Tauri	6	6 57	33	7 53	303
„ 6	5 Cancri	6	10 42	41	11 39	311
„ 8	A Leonis	5	12 3	13	12 51	299
„ 28	μ Ceti	4	9 25	75	9 48	29
„ 29	f Tauri	4	5 25	57	6 5	3

Star Observations.—Our space scarcely admits of any remarks on star-observing this month. We will content ourselves, therefore, with remarking, that, about the middle of the month, the sidereal time at six o'clock in the evening will be 3h. 40m.; and that, therefore, all objects of Right Ascension greater than that, and less than ten hours, will be readily observable in the evening throughout the month. The season is usually the most favourable one for observing double, triple, etc., stars, star-clusters, and nebulæ. Of these, very useful working lists will be found in Book VI. of Chambers's "Descriptive Astronomy."*

The Moon.—February 1. First quarter at 6h. 15m. P.M. Plato near the north point. Nearer the centre, Eratosthenes and Stadius. Beyond these the remarkable formation, called Schröter, by its discoverer Gruithuisen. Near the south point, Tycho. To its north is the Mare Nubium.

February 2. This evening Copernicus (fifty-six miles in diameter), will be on the terminator. The region between this and Eratosthenes is remarkable for a very large number of minute craters. To the north of Copernicus lies Mare Imbrium.

February 4. Kepler will be in view. South of it the distinctly green Mare Humorum.

February 5. Aristarchus in view. Curious variations in the light have been noticed: a subject quite recently again called attention to by Herr Tempel.

February 8. 9h. 35m. A.M. Full Moon. The Mare Crisium, a conspicuous dark grey plain, with an occasional trace of green,

* A New Edition of Mr. Webb's excellent work is in the press.

may be profitably observed about this time for colours, tints, and visibility of its numerous objects.

February 23. 2h. 20m. P.M. New Moon.

February 25 and 26. The terminator will pass over the Mare Crisium and Mare Fœcunditatis.

February 27. Over the Mare Tranquillitatis and Mare Nectaris. Beyond the latter, to the north-east, is the large and very deep crater Theophilus, with central peak 5200 feet high.

February 28. Posidonius, a remarkable walled plain, sixty-two miles across, bounding Mare Serenitatis on the west, will come into view late in the evening.

February 29. The terminator will pass over that M. Serenitatis, in the north-western quarter of the Moon. It contains, besides Bessel and Sulpicius Gallus, the remarkable little crater Linné, or Linnæus, about which there has been so much discussion during the past year. Beyond the Mare, is the magnificent range of the Lunar Apennines, some of the ridges and peaks of which will come into view during the night.

STORMS AND HURRICANES: THEIR MOTIONS AND CAUSES.

BY HENRY WHITE, PH.D.

IT is a common, and, we believe, very erroneous opinion, that the elemental catastrophes of recent years have been more severe and destructive than those of past times. The error is easily explained. By means of the electric telegraph, and our rapid steam communication, the news is conveyed so quickly to us, that we almost seem to be present at the scene of disaster, and therefore realize it more vividly. It is, as it were, almost next door to us. But a few years ago, the tidings of an earthquake or of a hurricane travelled slowly, and the general public regarded it "as a sorrowful tale long past." Severe as was the "Royal Charter" gale of 1859, it did not probably exceed in violence that of November, 1703, which fell under the observation of Derham, and was described by him in the twenty-fourth volume of the "Philosophical Transactions," and by Defoe, in his account of the Great Storm. The year had been remarkable for the excessive humidity of the spring and summer months, and particularly of May, when more rain fell than in any

month of any year since 1690; and, although the wetness of the season may have had nothing to do, immediately, with the storm, it must, in some degree, have affected the atmospherical conditions of the country. On the 25th of November the wind began to rise; on the 26th its fury augmented, "until at midnight," says Derham, "the storm awakened me. It gradually increased until near three in the morning, and continued until seven with the greatest violence." The storm swept over all England south of the Trent, marking its course by disasters rarely exceeded in tropical climates. Oldmixon describes its doings in London:—"The wind blew west-south-west, and grumbled like distant thunder, accompanied with flashes of lightning. It threw down several battlements and stacks of chimneys at St. James's Palace, tore to pieces tall trees in the Park, and killed a servant in the house. A great deal of lead was blown off Westminster Abbey, and most of the lead on the churches and houses was either rolled up in sheets or loosened." Among the more distinguished victims of this elemental strife were "that pious and learned prelate, Dr. Richard Kidder, Bishop of Bath and Wells, and his lady, who were killed by the fall of part of the old episcopal palace at Wells. The Bishop of London's sister, the Lady Penelope Nicholas, was killed in like manner at Horsely, in Sussex, and Sir John Nicholas, her husband, grievously hurt." The number of undistinguished victims who lost their lives, at sea and on shore, during this tempest, has been computed at more than eight thousand. Three hundred sail were wrecked upon the coast; nine hundred wherries and barges destroyed on the Thames; Rear-Admiral Beaumont, with the crews of several ships, perished on the Goodwin Sands; and the Lighthouse at Eddystone, built by Winstanley, was swept away, along with its builder, so that not a fragment was ever found again. One hundred churches were unroofed; four hundred windmills and eight hundred houses blown down; a quarter of a million of forest and fruit-trees levelled with the earth; and fifteen hundred sheep and cattle drowned by the overflowing of the Severn. The whole nation was for a moment prostrated with terror: many fanatics thought the last day had come—they even imagined that they had heard the trump of the archangel in the blast; and it was many a long year before people could speak of the Great Storm, or of Black Friday, without a shudder.

This visitation of November, 1703, was, in common language, a storm or a tempest—by which is loosely signified a fierce wind blowing in one direction without shifting (as here, from south-west

to north-east); but, from the few scattered observations we have been able to discover (such as the shifting of the wind from S.W. to N.W.), there seems reason to believe that this November storm was in reality part of a hurricane or cyclone. It had probably originated in the usual birth-place of the cyclones, and followed their customary direction until, in the middle of the Atlantic, the centrifugal force proved too strong: it flew asunder—as we have seen the tire of a fly-wheel separate, one portion going off we know not where, the other flying in a tangential line to its original course—to dash with unrestrainable violence upon our shores.

Turning to the more immediate subject of this paper, we shall begin with a description of two of the most tremendous visitations of physical power that have ever been let loose upon our globe. They both occurred in October, 1780, and are amply recorded by Colonel Reid in his "Attempt to develope the Law of Storms," published in 1838. The first happened on the 3rd October, when, after the fury of the tempest had abated, the waves rose to an amazing height, and rushing with indescribable impetuosity on the shore, swept away the town of Savannah-la-Mar, in Jamaica. At Montego Bay, prodigious flashes of lightning regularly succeeded each other, lighting up the midnight darkness which brooded over the general desolation. A still more furious hurricane burst forth on the 11th October. At Barbadoes, the inhabitants were driven from their houses, and forced to seek what shelter they could find in the fields during the night, exposed to all the fury of the elements. A ship was dashed on shore against one of the buildings of the Naval Hospital, and the bodies of men and cattle were lifted from the ground, and carried many yards. Trees were uprooted, all the fruits of the earth were ruined, and more than three thousand of the inhabitants destroyed. At St. Eustatia, seven ships were beaten to fragments on the rocks, and their crews lost. In the night of the 10th, every house to the northward or southward was blown down or washed into the sea, a few only escaping. In the afternoon of the 11th, the wind shifted suddenly to the eastward, and at night it blew with such fury as to sweep away every house. Six thousand people were destroyed, mostly by drowning. At Port Royal, one thousand four hundred houses, besides the churches and public buildings, were blown down; and about one thousand six hundred sick and wounded were almost all buried in the ruins of the hospital of Notre Dame. At the town of St. Pierre, in Martinique, every house was blown over, and more than one thousand people perished. At Barbadoes, though the walls of the Govern-

ment-house were three feet thick, and the doors and windows had been barricaded, the wind forced its way into every part, and tore off a large portion of the roof. The governor and his family retreated to the cellar, which they were compelled to leave on account of the entrance of the water. They then fled for shelter to the ruins of the foundation of the flag-staff, and when these gave way also, the party dispersed. The governor and the few that remained were thrown down, and with difficulty reached the cannons, under the carriages of which they took shelter. Many of the guns were thrown down by the fury of the gale, and they dreaded every moment either that those over their heads would be dismounted, and crush them by their fall, or that some of the flying ruins would put an end to their existence.

The Barbadoes hurricane of 1831 was another peculiarly calamitous visitation, destroying the lives of one thousand four hundred and seventy-seven persons in the short space of seven hours. At St. Vincent's, one of the inhabitants noticed a cloud to the northward of so threatening an aspect, that he had never seen anything like it during his residence of forty years in the tropics: it was of an olive-green colour. He hastened home, and by nailing up his doors and windows, saved his house from the general calamity. The water of the sea was raised to such a height in Kingston Bay as to flood the streets. The waves broke continually over the cliffs at the north point, a height of seventy feet, and the spray was carried inland by the wind for many miles, and in such quantities that the fresh-water fishes in the ponds were killed. At Barbadoes, the storm was ushered in with variable squalls of wind and rain, and intervening lulls. About five o'clock in the afternoon of the 10th August, a dismal blackness gathered over everything, with the exception of an ominous circle of obscure light towards the zenith. Shortly after midnight, the paroxysm of the storm occurred, the wind shifting from the north-east to the north-west. Incessant flashes of lightning illuminated the upper regions; but, says an eye-witness, the editor of the "West Indian," "the quivering sheet of blaze was surpassed in brilliancy by the darts of electric fire which were exploded in every direction. A little after two, the astounding roar of the hurricane cannot be described by language. At intervals the lightning flashes ceased, when the blackness enveloping the town was inexpressibly awful. Fiery meteors rained from the heavens; one in particular, of globular form and deep red hue, fell sheer down, growing white hot (as it were) in its descent, and elongating as it neared the earth,

against which it dashed, splashing its fiery fragments all around, as if it had been a mass of melted metal from the furnace. Now followed a brief silence, during which the wind fell to a distant roar. The clouds sank so as nearly to touch the houses; flaming streams of electricity poured downwards, and were returned in rapid succession upwards from the earth, resembling the quick, irregular discharge of opposing artillery closely engaged. Again the storm burst forth, and with increased violence, hurling before it thousands of missiles, the fragments of every unsheltered structure of human art. The strongest houses shook to their foundations, and the surface of the earth trembled. No thunder was at any time distinctly heard; it was probably drowned by the horrible roar and yelling of the wind, the noise of the sea, and the crash of falling roofs and walls." The rain (or spray) was driven with such violence as to injure the skin. At daybreak, when the storm had considerably abated, the prospect was "majestic beyond description." "The gigantic waves rolling onwards, seemed as if they would defy all obstruction; yet, as they broke over the careenage, they seemed to be lost, the surface of it being entirely covered with floating wreck of every description. It was an undulating body of lumber—shingles, staves, barrels, trusses of hay, and every kind of merchandise of a buoyant nature. Two vessels only were afloat within the pier, but numbers could be seen which had been capsized or thrown on their beam-ends in shallow water." The whole face of the country was laid waste; no sign of vegetation was apparent, except here and there small patches of a sickly green. The surface of the ground appeared as if fire had run through the land, scorching and burning up the productions of the earth.

In 1837, at the island of Tortola, (the same which was reported to have been submerged in the hurricane of last October), thirty-six vessels were wrecked, and more than one hundred seamen drowned. Some houses were turned bottom upwards, and one large, well-built house was torn from its foundations, and carried upright into the middle of the street. The fort at the entrance of the harbour was levelled with the ground, and the 24-pounders were thrown down. Governor Rumbold, describing the effects of the recent hurricane, says: "The face of nature, as by a miracle, was transformed; it appeared as if winter had visited the tropics; for the few trees that stood, and all vegetation, were withered by the desolating blast." These illustrations being sufficient to give an idea, though it may be a faint one, of the horrors of a West Indian hurricane, we shall next bring together some special phenomena, and

then endeavour to explain the modern theories on the subject.

The light in the zenith, observed at Barbadoes, was also noticed during the Antigua hurricane of July, 1837, by the captain of the "Judith and Esther":—"The wind was blowing fresh from the N.E., when I observed near the zenith a white appearance of a round form, and while looking steadfastly at it, a sudden gust from the N.E. carried away the topmast and lower studding-sails." There are other instances of this curious phenomenon, when the wind appears to stoop like a bird of prey. They are probably connected with the gyratory motion of the air, and may be compared to the little whirls that may be observed on water, occasionally darting off erratically from some larger whirl; or to the tiny eddies that play fitfully about on a hot summer's day, as if a troop of atmospheric fairies were amusing themselves. In tornadoes (which we may call concentrated hurricanes), the roof has been torn off one house standing among many, the rest of the house being untouched. Trees in a grove have likewise had their tops cut clean off, while others to the right and left have been uninjured. The description of the "white spot" seen at Barbadoes (the wind blowing from the northward) appears to support the gyratory explanation:—"It remained at rest for a very few moments, when the scud of it was to be seen in a state of ebullition. The dense mass of clouds all around was agitated, and separating bodies of it were quickly dispersed to all points of the compass." During the "Royal Charter" gale of October, 1859 (which was a cyclone), this strange light in the zenith was observed at Holyhead. "About seven P.M.," (says an eye-witness), "I was startled by what appeared to be a bright belt of fire directly over my head, the light of which was intense. It pierced through the heavy mass of vapour which obscured the heavens, and illuminated the whole bay and land with the light of day. This meteor (?) lasted from two to three seconds. Very soon after this the wind increased to a hurricane." The luminosity of this meteor and the obscurity of the Barbadoes "circle of light," may be accounted for by the fact, that one was seen by night, the other by day.

The peculiar noise of the wind is another striking characteristic of the hurricane, as well as the impenetrable darkness by which it is sometimes accompanied. One seaman speaks of the hurricane bursting out afresh "with the most tremendous, unearthly screech he had ever heard." Another describes the wind as "representing numberless voices elevated to the shrillest tone of screaming."

This furious screaming, heard alike at sea and on shore, deserves more notice than it has hitherto received. The captain of the "Duke of Manchester" says: "A most remarkable phenomenon presented itself to windward almost in an instant. It resembled a solid black perpendicular wall, about 15° or 20° above the horizon, and it disappeared almost in a moment. It then reappeared as suddenly, and in five seconds was broken, and spread as far as the eye could see." "This black squall," continues Mr. Griffiths, "was the most appalling sight I have ever witnessed." One of the officers of H.M.S. "Tartarus," which was caught in a hurricane off the American coast in September, 1814, says, that after the tempest had continued for four hours with a mountainous sea, the barometer sank beneath the wood of the frame, and the scenery of the sky became indescribable. "No horizon appeared, but only something resembling an immense wall within ten yards of the ship." Captain Macqueen, of the "Rawlins," speaks of a "dismal appearance" seen at the N.W., which seems to be the "black wall" of other navigators. Perhaps connected with this phenomenon may be the following extract from the log of the "Castries," from Liverpool, in N. lat. 15° 4′; W. long. 54° 58′. "Land was discovered on the lee bow, having the appearance and broken outline of a West Indian island." The captain prepared to alter his course, when on looking again, the supposed island had vanished. He afterwards heard of the hurricane of Santa Lucia (July, 1837).

Very remarkable electric phenomena accompany most hurricanes. Some have been described already, but the following belong to quite another order of facts. Captain Seymour, of the "Judith and Esther," says:—"For nearly an hour we could not observe each other or anything, but merely the light (lightning?), and, most astonishing, every one of our finger-nails turned quite black, and remained so nearly five weeks afterwards." In the Barbadoes hurricane of 1831, a large portion of the trees in a forest at St. Vincent's were killed without being blown down. Colonel Reid, who frequently examined them, is of opinion that they were destroyed by the extraordinary quantity of electric matter rendered active during the storm. At Barbadoes, during the paroxysm of this very hurricane, two negroes were greatly terrified by sparks of electricity passing off from one of them, as they were struggling through the garden of Coddrington College to a place of shelter. In some well-authenticated reports of tornadoes, sparks have been seen to issue from the sand as it was driven through the air. Lieutenant Spey describes another peculiarity of electricity when in very energetic

action, though somewhat similar manifestations have been witnessed in the monsoon storms:—"Every flash of lightning," he says, "was accompanied with an unusual whizzing noise, like that of red-hot iron plunged in water."

It is still a question whether hurricanes are accompanied by earthquakes or not. In the hurricane of 1780, when Savannah-la-Mar was destroyed, after the waters began to abate, a most severe shock of an earthquake was felt. Writing about Barbadoes, Sir George Rodney says in his official despatch that "Nothing but an earthquake could have occasioned the foundations of the strongest buildings to be rent;" and he was convinced that "the violence of the wind must have prevented the inhabitants from feeling the earthquake, which certainly attended the storm." The logic is not conclusive, but the science of meteorology teaches us in what manner it is possible for the surface of the earth to be affected during a hurricane, so as (at least) to produce the great oceanic waves that so often accompany the tempest. During the late hurricane at Tortola the barometer suddenly fell two inches—equivalent to a decrease of pressure represented by one pound avoirdupois. One pound per square inch is over one and three-quarter million (1,792,183) tons per square mile. Is it possible for the earth to remain unaffected by the removal of this pressure? The apparently firm surface upon which we tread is in reality but a thin crust spread over a fiery incandescent gulf below, where all kinds of volcanic action are at work and pent-up gases struggling to find a vent. When the pressure of the atmosphere is removed, these gases would force the crust upwards, displacing the foundations of buildings and toppling down the summits of mountains. The earth trembles, not from the fury of the blast, but from the motion communicated to the surface from beneath. This upheaval and subsidence is always going on over the whole superficies of the globe; but what takes place slowly in obedience to slow barometric changes, in the hurricane may take place violently in proportion to the rapidity of the barometric fall. We would not lay too much stress upon this theory, but it appears to be at least worthy of investigation. It seems confirmed by a curious circumstance not unfrequently noticed, especially in tornadoes, namely, the bursting of doors and windows outwards from within—a phenomenon apparently the result of a sudden diminution of atmospheric pressure on the outside of the building. It has also been noticed that when the ridge of a house runs at right angles to the direction of the wind, the windward slope remains uninjured, or almost so, while the leeward or unexposed

slope is utterly destroyed. Perhaps both phenomena may be explained on the same principle. We may suppose the windward slope to be kept in its place by the pressure of the blast, while the leeward slope is destroyed by the rarefaction of the air. Says Professor Loomis:—"A current of air forcibly impelled over an obstacle like the roof of a building, by friction drags along with it the air lying upon the leeward side of the roof, producing a partial rarefaction, which might easily be sufficient to lift the roof." The rarefaction required to produce this effect is much less than might be imagined. Supposing a barometer above the roof to show a fall of only one-tenth of an inch lower than within the building, there would be an upward force of seven pounds per square foot, quite sufficient to throw off the roof of a barn or stable.

Attempts have been made to calculate the velocity of the wind in a hurricane, but as yet the results are extremely vague and unsatisfactory. "The blast struck us like the discharge of a cannon," says one seaman. "During the heaviest of the gale, the sea was smooth," says another. "The wind was so strong that it beat down the waves." Other witnesses add: "The tops of the waves were quite cut off. The sea-drift flew across the deck with such fury that no one could withstand its force." In the hurricane of 1825, by which Basseterre in Guadaloupe was destroyed, three 24-pounders were blown away, and a piece of deal, 37 inches long, nine inches wide, and seven-eighths of an inch thick was driven through a palm-tree, 16 inches in diameter. In a whirlwind felt at Calcutta (April 8, 1833), a long bamboo cane was forced through a wall five feet thick, so as to pierce the facing of the wall on both sides. The editor of the "Indian Review" remarks that a 6-pounder gun could hardly have produced the same effect. At Santa Lucia in 1780, cannon were carried more than a 100 feet. Some extraordinary stories (which need confirmation) are told of the force exerted by the wind at St. Thomas's during the hurricane of last October. The signal gun on the ramparts was forced through the parapet wall. A diving bell, a bulk of about nine tons, was lifted and carried away nearly a quarter of a mile. A piece of scantling, 25 feet long, was driven through the roof of a house, through the back of a rocking-chair, and then through the floor, resting on the counter of the shop underneath. Stranger still, a stone, supposed to weigh 40 tons, was so moved that it had a ship's sail spread under it, "much in the same way as a table-cloth would be laid on a table with a large dish-cover set in the middle."

In the Stow Tornado of 1837, and in that of New Haven, 1839, several fowls were picked up almost stripped of their feathers. A similar thing was noticed at Mayfield in 1842. Professor Loomis supposes this new mode of plucking geese to have been effected by the velocity with which the birds were driven through the air; and from a curious but rough experiment made with a 6-pounder, he concludes that a speed of 100 miles an hour would be sufficient to strip off the feathers. After this, we almost feel inclined to take seriously the old "yarn" of the wind blowing so hard, that it swept all the hair off one man's head, and turned the head of another half way round. In the great storm of December, 1852, which will be fresh in the recollection of many readers, the velocity of the wind was calculated at 57 miles an hour. In the "Royal Charter" gale of October, 1859, the wind reached a maximum varying at different places of 60 to 100 miles an hour.

Smeaton estimated the utmost pressure of a hurricane at 46 lbs. to the square foot, and this (though practically considered much exaggerated) was the standard adopted by Stephenson in his calculations for the lateral rigidity of the Menai tube. But there seems to be good reason to believe that the maximum is far higher. On the 18th June, 1839, a considerable portion of a park wall at Chatenay, 6 feet high and 18 inches mean thickness, was thrown down bodily, as if turning on a hinge, and from observations made on the spot shortly after, it is possible to estimate numerically the force necessary to produce such an effect. If we suppose a to represent the vertical height, b the length, and c the thickness of a wall whose transverse section and base are rectangular, w being the weight of a cubic foot of masonry, the moment of resistance to rupture will be represented by $\frac{1}{2}\, a\, b\, c^2\, w$. Again, if p is the pressure per square foot, the force brought to bear against the wall is expressed by $\frac{1}{2}\, a^2\, b\, p$. Equating these expressions, we have $p = \frac{c^2\, w}{a}$. Now if we take $c = 1.5$ ft., $a = 6$ ft., and $w = 222$ lbs.; then $p = 83$ lbs. But by neglecting to take into account the adhesion of the mortar, we have a result far below the truth; and to correct this, we will employ Navier's formula ("Leçons de Mécanique Appliquée," pp. 70, 73), where $p = \frac{\mathrm{R}\ c^2}{3\, a^2}$. According to Vicat, the worst mortars give a resistance of (roughly) 2080 lbs. the square foot. Assuming this value for R, then $p = 44$ lbs. nearly. Adding, therefore, this new value to the power, the force exerted against certain parts of the overthrown wall must have

been at least 83 + 44, or 127 lbs., at the moment when the wall fell. This result, which is probably far below the truth, may be explained if we suppose that, during the passage of the whirlwind, a vacuum was formed on the lee of the wall, towards which the air rushed with a velocity partly due to atmospheric pressure, which, in round numbers, we may take at 2200 lbs. per square foot—more than sufficient to produce the effect described. The velocity of the wind sufficient to produce a pressure of 127 lbs., amounted to 135 feet in a second, or 92 miles an hour.

We reserve for another opportunity our discussion of the causes, motions, and paths of cyclones, as well as their periodicity and other matters connected with their dynamics.

ARCHÆOLOGIA.

The city of Bath occupies the site of one of the most fashionable towns of Roman Britain. It was called by the Romans *Aquæ Calidæ*, literally the warm baths, and *Aquæ Solis* the baths under the auspices or protection of the sun (taking the sun as a deity); for at this early period it was as celebrated for its baths as in modern times. Traces of magnificent temples, the principal of which is said to have been dedicated to Minerva as the patron goddess of the place, have frequently been met with in digging, and inscriptions found there at different periods show that military commanders, high municipal officers, and other persons of rank, frequented this city for the benefit of its waters, and probably, also, to mix in its fashionable society. Some very recent excavations have brought to light further relics of the Roman city and of its people. These excavations have been made upon a site rather celebrated in the antiquarian annals of the modern city—that of the old White Hart Hotel. Older excavations, made in the latter years of the last century, at the top of Stall Street, near the White Hart, brought to light remains which appeared to be those of part of a vast temple, and which were supposed to be those of the famous temple of Minerva. They are described as lying on the eastern side of the great Fosse road, which ran through the Roman town from north to south, and about the middle of the town. The temple fronted the west, the front consisting of a portico supported by very large fluted columns of the Corinthian order, crowned with rich sculptured capitals. The architraves bore inscriptions to the Deæ Campestres, well-known local objects

of Roman worship, and to other local deities, and the frieze was enriched with gigantic images, figures of animals, and groups of foliage. These facts we learn from Collinson's "Antiquities of Somerset," published in 1791. A portion of the frieze of the great temple thus discovered has been preserved in the Museum of the Bath Literary and Scientific Institution; the continuation of this frieze has been found in the recent excavations. The basement of a large building has also been traced, and the excavations have laid bare a sort of concrete pavement, which, from its character and extent, leads to the inference that there had been a large area or parade-ground adjoining the temple. In the year 1755, the foundations of the splendid Roman baths were found at a depth of twenty feet beneath the modern surface of the ground, at a little distance to the east of—that is, of course, behind—the temple of Minerva just mentioned. The recent excavations have also been carried to a great depth; and they passed through eighteen inches of red clay largely impregnated with iron, which is supposed to have been the sediment of the Bath waters. Immediately above this clay the foundations of the Roman period were found.

While speaking of Bath, we may refer to a recent publication of the Camden Society, a sort of antiquarian journal of Thomas Dingley, who lived in the reign of Charles II., under the title of "History from Marble." Dingley's journal is especially full on the city of Bath, and, among many other things, it contains descriptions much fuller and more correct than those we previously possessed of many Roman monuments now lost, and of a few which were not previously known. At that time it appears to have been quite common to find stones with Roman inscriptions or sculptures in the walls of the houses, etc., of Bath, and more especially in the town-walls, and he has preserved the fragment of an inscription of one of those which was then visible in the wall between the north and east gates of the city, consisting of the following words :—

DEC · COLONIAE GLEV ·
VIXIT AN · LXXXVI ·

It is part of a sepulchral monument to the memory of a *decurio*, or member of the *curia*, or senate, of the city of *Glevum* (Gloucester), who had lived, at the time of his death, eighty-six years. It is commonly supposed that the climate of Britain was not favourable to the health of the Roman colonists, but here is a municipal officer of Roman *Glevum* who had reached the age of eighty-six, and, even at that advanced age, had gone to seek restoration of health, for he could hardly have been in search of fashionable

society, in the baths of *Aquæ Solis*, and to leave his bones there.

At the time of the meeting of the British Archæological Association at Ludlow, in the beginning of August last year, an interesting discovery was made at BROADWARD in that neighbourhood, which has not yet been noticed in print. Broadward is in the parish of Clungunford, and both it and the village of Clungunford are close upon the line of the Roman road, and at each there is a fine tumulus, or barrow, no doubt of the Roman period. At the date of which we are speaking, some diggings were in progress for the purpose of draining a piece of swampy land at Broadward. In the course of their work, the drainers came upon a very large deposit of spear-heads, swords, axes or chisels (commonly called celts), knives, and other implements, made of bronze, a portion of which were only disinterred, and these amounted, we believe, to upwards of a hundredweight. This belongs to a class of discoveries which have been very numerous in this country, and the objects thus found, were no doubt the stock-in-trade of a manufacturer of such articles; probably an itinerant manufacturer, who moved from place to place, making and selling. We believe in every case, or at least with very few exceptions, these deposits are met with in the immediate neighbourhood of Roman stations, or Roman roads, as in the case of which we are now speaking, and we feel no doubt in ascribing them to the Roman period. A small quantity of pottery was found with these remains at Broadward, the forms of which, to judge by some rude sketches sent us, are decidedly Roman in character; but we hope, on a future occasion, to be able to give more minute details. A remarkable circumstance connected with this discovery is that the bronze has undergone a considerable degree of decomposition, arising no doubt, from the character of the ground and the water in which they have so long lain, in consequence of which many of them were found compressed together into solid masses. The sockets of the spear-heads, formed to receive the ends of the shafts, appeared at first sight to be filled with something like iron ore, but it turned out on examination to be merely a formation from the decomposition of the bronze.

While speaking of LUDLOW, and of BRONZE IMPLEMENTS, it may be well to remark, that a very interesting collection of these objects, found in 1862, in a field near Guilsfield, in Montgomeryshire, known by the name of "The Camp," are preserved in the museum at Ludlow. Guilsfield is a village at the foot of the hills some three miles to the north by west of Welshpool, and a little to the south of

extensive hill-entrenchments called Gaer-Fawr; we believe that this name *gaer* or *caer*, derived directly from the Latin *castrum*, will be found always to indicate a Roman site, as is the case in England with the word *chester*, derived from the same origin. This hill-station, as well as "The Camp" field below, were probably Roman positions connected with the extensive copper and mining operations carried on by the Romans in this district. Some of the bronze objects found in "The Camp" field, as mentioned above, were described by Mr. Samuel Wood, F.S.A., of Shrewsbury, in a notice printed in the "Proceedings of the Society of Antiquaries of London," on the 16th of April, 1863, and these may now be seen, as stated above, in the local museum at Ludlow, to which we believe they were presented by the Earl of Powis. They consist of fragments of swords, the end of a sword sheath, spear-heads, "celts," and two ferules, all of bronze. The last-mentioned objects present a character which can hardly be other than Roman.

A somewhat extravagant degree of importance has recently been given to the discovery of a polished STONE HATCHET near MALTON, in Yorkshire. It is well known that Malton, or rather Old Malton, on the opposite side of the river Derwent, is the site of a Roman town, in all probability that which was called *Derventio*. It appears that a labourer was digging gravel from the oolitic beds near Malton, when he found this stone implement at, he said, a depth of about nine feet, but, as no notice was taken of it till two or three days after it was found, we cannot rely on the strict accuracy of this statement. This object subsequently fell into the hands of a gentleman who considered it of so much importance, that full-sized photographs were made of it, as well as a view of the gravel beds, and supplied to various parts of the country. We are further informed that more recently a half-fossilized bone, presumed to be part of the leg-bone of an ox, has been found in the same gravel beds.

The Yorkshire papers inform us of interesting discoveries made in November last in a field in the township of AMOTHERBY in the parish of Appleton-le-Street, some four or five miles from Malton, which seems to indicate the former existence of a large ROMAN VILLA on that spot. The discovery was the result of mere accident, which is the more remarkable as the Roman pavements appear to have lain in some places hardly more than six inches below the surface of the ground, and nowhere more than two feet and a half. These pavements are all of considerable extent, indicating a series of very large rooms, though no remains of the walls have yet

been found. These had perhaps been rooted up at some remote period for the sake of materials. One of the pavements is stated to be a hundred and fifty feet across, and must have been that of a court. The construction of these floors appears to have been rather unusual in character, for they are described as "paved with blocks of oolite, limestone, and sandstone—the latter mostly burnt quite dark in colour—and sea pebbles; in some parts flat slabs of limestone being paved edgewise." Abundance of broken Roman pottery of all kinds, from the valuable Samian ware to that of the rudest description, has been found. Among the animal remains are those of the ox, deer, hog, dog, and different species of birds, with a nearly complete skull of the wild boar. We may mention, among other objects met with, several portions of querns, half of a very small horse's shoe, not grooved, other fragments of iron, too much broken or corroded to enable us to judge to what implements they had belonged; a much defaced silver coin, two small brass coins of Constantine, and several peculiarly rubbed sea-pebbles and other stones, some grooved. It is also worthy of remark that among these Roman remains of a rather late date, were found some of the implements of stone which it is now the fashion to ascribe to a "stone age," such as "a remarkably fine red flint 'scraper,' a flint 'drill,' and some other flints, with a 'spindle whorl' of Samian pottery, and another similarly formed (unpierced) of stone." It appears that the nature of the ground is not favourable to excavations during the winter; but we are informed that the gentleman under whose direction they have been carried on, the Rev. James Robertson of Appleton, intends to resume them on the return of favourable weather.

T. W.

PROGRESS OF INVENTION.

MANUFACTURE OF ALCOHOL.—To prevent the formation of acids in the distillation of alcohol, and to neutralize any which may have been previously formed in the wash to be distilled, Mr. J. Fletcher Collins, of New York, has patented a process, in which he employs phosphate of lime to effect this object; and, still further with a view to prevent the formation of acetic acid, he conducts the distillation at a temperature not exceeding 176° F. At this low temperature, the vapours would not pass over freely; he therefore causes a current of air, or some suitable non-deleterious gas, to drive them from the still, instead of depending on excess of heat for their expulsion. In order to get sufficient pressure, the air or gas is introduced into the still through a pipe passing perpendicularly into it, and this pipe is carried to any convenient height, greater than a column of water at the normal pressure of the atmosphere. It is then bent downwards, and extended to the condenser in that direction, and by a similar pipe between the condenser and the still, the current is completed. This extension of the perpendicular pipe causes any aqueous vapour which might be formed to be retained.

FIREPROOF FLOORS AND CEILINGS.—It seems strange that more attention has not been given to rendering houses less liable to be destroyed by fire than they are at present. The employment of bad conductors of heat for the protection of the more inflammable materials which must of necessity be used, will, in a great measure, effect this object. If the floors and ceilings can be rendered comparatively fire-proof, there will be little danger of a fire, accidentally kindled, extending beyond the room in which it originated. A very simple and useful invention has been patented by Mr. John Thompson, of Carlisle, in which he proposes to place between the wood floor-joists a layer of cement, made of plaster of Paris or some other suitable non-conducting material, so laid as to form a smooth surface above the joists on which the flooring boards may be placed, or which will itself answer as a floor. To form a good bed for the cement, the joists are cut thinner at the top than below; this arrangement also has the effect of lightening the structure, which object may be still further attained by leaving hollows in the cement, between its upper and lower surfaces. These hollows are formed by earthenware tubes, or by others made of the cement itself. In this way all the constructive timber can be protected from fire, even should the flooring-boards, when they are used, be entirely consumed.

INDICATING TAPS.—It certainly is very desirable to be able to measure the quantity of beer or other liquid which has to be drawn in small quantities from a cask. An ingenious method of doing this has been invented by Mr. John Wood Ridley and Mr. John Withers. They make their tap so that it contains a hollow cylindrical chamber, in which another works which fits the first very accurately. The outer cylinder

or casing has two holes made in it of corresponding size, the one made in the upper part is the inlet passage, that below is for the passage out of the liquid. The inner cylinder is provided with one or more holes, which can be made to correspond with those in the outer casing, and can be turned round so as to allow one of its apertures being brought opposite to the inlet passage of the outside cylinder. The liquid is then free to flow from the cask and fill the inner cylindrical chamber; this is then turned round until its aperture corresponds with the outlet passage in the outer casing, the liquid then of course flows out. The inner cylinder is made to contain a known quantity, and, by a simple contrivance, can be made to register on an index the number of times it has been filled and emptied. The registering dials are arranged outside the tap, the pointers indicating somewhat after the manner of those used in gas meters.

Conversion of Cast into Wrought Iron.—To burn out the carbon from cast iron by a cheap process, is a subject which has long engaged the attention of practical and scientific men. One which has lately been patented by Mr. John Heaton deserves consideration; the only question seems to be whether it is sufficiently economical to ensure its adoption. The principle on which it is founded, and the method of its application, seem excellent. The conversion of the carbon by nitrate of soda or chlorate of soda is the method he adopts; he also claims salts of potash as well as of soda. The application of these oxidizing agents is to be to the under surface of the molten iron, so that the oxygen may act from below upwards through its mass. The nitrate or chlorate is to be placed in chambers within the receiver of the melted iron, which is made to revolve, so that the chambers may come under the molten metal, and the nitrate or chlorate may act through it. The surface of the nitrate or chlorate is protected from a too rapid action of melted iron by means of an iron plate perforated with numerous holes. Mr. Heaton says, that if the cast iron contains about five per cent. of carbon, one hundredweight and a quarter of nitrate or chlorate will be sufficient for each ton of iron, and that the effect will be produced in three minutes. The same process may also be used for the conversion of cast iron into steel.

Peg Fastenings for Boots and Shoes.—This invention of Mr. Briggs Smith, of Boston, U.S., seems to have so many other applications than simply to the manufacture of boots and shoes, that it seems worthy of notice. To avoid the expense of cutting a screw Mr. Smith uses a polygonal wire, which is twisted by a machine of his invention, before patented. This twisted wire is cut into suitable lengths for pegs, or for any other purpose to which it is to be applied. They can be driven in with a hammer in the usual way when once started in a hole prepared for them. The peg on being driven turns and holds very firmly.

A Portable Lamp.—There are often occasions when a portable lamp

would be found very useful; one, which immediately occurs to the mind, is when in railway carriages the lamps provided by the company are not in good order, a circumstance which not unfrequently happens; such a lamp would then enable the traveller to occupy the weary hours with his book or newspaper. An American has invented a portable lamp of very simple construction; it consists merely of a long tube, or wick holder, provided at its upper end with a nozzle through which the wick protrudes, it has a shoulder on which a screw is tapped, which is screwed into the open end of the tube of a walking-stick, which forms the oil chamber. When the lamp is not in use the nozzle and wick are covered by the handle, or top of the stick, which is screwed on to the hollow part, and can be made to hold matches. The same apparatus can be arranged with a helical spring, so as to burn candles like an ordinary Palmer's lamp; a portable glass shade can be screwed on to the top of the walking-stick.

VINEGAR MANUFACTURE.—There is a very general complaint that the oxidation of spirits of wine in the vinegar process is far from complete, and that the results are not equal either in quality or quantity to what ought to be expected from the materials employed. Dr. Artus has made investigations in order to make the process more perfect, and he says that the success of a method which he discovered was perfectly satisfactory; that the oxidation was rapid and complete, and that the vinegar produced was of good quality and possessed an agreeable smell. He took half an ounce of dry bichloride of platinum, and dissolved it in five pounds of alcohol; with this liquid he moistened three pounds of wood charcoal broken in pieces to the size of a hazel-nut; these he heated in a covered crucible, and afterwards put them in the bottom of a vinegar vat. Here the platinum in its finely divided spongy state absorbs and condenses large quantities of oxygen from the air by which the alcohol is rapidly oxidized. When the charcoal has been in use for five weeks it should be again heated in a covered crucible.

PROCEEDINGS OF LEARNED SOCIETIES.*

ROYAL ASTRONOMICAL SOCIETY.—*January* 10.

A FEW papers were read on the meteoric shower last November, and one containing an observation of Jupiter as seen without satellites exterior to his disc.

Mr. De La Rue announced that some of the results of the photo-

* Interesting matter that comes before the Royal Society will usually be found cited from their "Proceedings" in "Notes and Memoranda."

graphic observations of solar spots at Kew would shortly be published. Those observations were now carried on simultaneously with Schwabe's at Dessau, and with equal continuity; and although from a better climate Schwabe more frequently saw spots, no important spot or group of spots was lost at Kew.

An announcement was made concerning Major Tennant's intended observation of the total solar eclipse in India next August. This gave occasion to Mr. Brayley to express a desire that the spectroscopical examination might include the most exterior atmosphere of the sun, perhaps beyond and containing the red flames, to see whether a discontinuous or gaseous spectrum could be traced in it. Mr. Joynson sent some further observations of Linné, and Mr. Buckingham orally communicated his own, purporting that he had seen changes in the position of the little crater in the white patch. Mr. Howlett compared this to what a lunarian might see on a smaller scale in Vesuvius.

Mr. Park Harrison read a paper on the amount of lunar radiation of heat at different parts of the lunation.

Mr. Stone announced a paper containing a new determination of the Moon's mass.

Mr. Browning described a new and very ingenious apparatus for observing the spectra of meteors.

ROYAL MICROSCOPICAL SOCIETY.—*January* 9.

J. Glaisher, Esq., President, in the Chair.

Professor T. Rupert Jones gave a very interesting account of the Entomostraca, and pointed out their abundance in geological formations of various periods. This paper was illustrated by an extensive collection of drawings and specimens.

LITERARY NOTICES.

THE FIRST PRINCIPLES OF MODERN CHEMISTRY. A Manual of Inorganic Chemistry for Students, and for use in Schools and Senior Classes. By N. J. Kay-Shuttleworth. (Churchill.)—THE FIRST STEP IN CHEMISTRY. A New Method of Teaching the Elements of the Science. By Robert Galloway, F.C.S., Professor of Applied Chemistry, Royal College of Science for Ireland, author of the "Second Step in Chemistry, a Manual of Qualitative Analogies," etc. Fourth edition, rewritten and enlarged, with illustrations on Wood. (Churchill.)—These two books are indications of the conflict of the old spirit of chemistry with the new. Mr. Kay-Shuttleworth, who has had the advantage of Dr. Frankland's assistance in revising his manuscripts and proofs, makes a very valuable attempt

to show how chemistry can be taught, so as to be a mental discipline as well as a valuable collection of facts, in strict conformity with Gerhardt's notation and the philosophy on which it is based. Professor Galloway re-edits an old work, which he wrote under the influence of ideas now abandoned by the best chemists, and which he enlarges by the addition of some matter compiled in conformity with the new system. He points out in his preface the importance of teaching chemistry so as to make it an instrument for developing the intellectual faculties, and then proceeds according to a plan which does not seem to us calculated to have any such effect. In this respect we should give a very decided preference to Mr. Kay-Shuttleworth's book, the plan of which is far superior to that of Mr. Galloway.

Our first objection to Mr. Galloway is his want of precision and accuracy of statement. In his first page he tells us "heat, light, and electricity cannot be exhibited in a mass, like wood, metal, water, air, etc.; they can be collected only through the intervention of other substances. They are likewise destitute of weight; hence they are called immaterial or imponderable bodies. They are considered to be produced by the vibrations of unknown and highly-elastic fluids, called ethers, which are supposed to fill the whole universe, and penetrate the pores of all solid and fluid bodies." Now, it would be difficult to compound a paragraph containing more unfounded assertions, suggesting more erroneous ideas, or less coherent with itself. First, we are told that heat, etc., cannot be exhibited in a mass, like wood, etc., and can only be collected through the intervention of other substances. What is the use of the commencing negation, and what can any one make of the affirmation? It is impossible to assign any definite idea to the phraseology, but it seems to indicate that heat and light are *substances*. Then we are told they are destitute of weight, and are called "immaterial bodies;" after which we are informed "that they are considered to be produced by the vibrations of unknown and highly-elastic fluids." We heartily pity the student who has to form a conception of an "immaterial body," capable of being collected by the "intervention of a substance," and "supposed to be produced by the vibration of an unknown fluid!" The following paragraph makes the confusion more confounded by further descriptions of heat, light, etc., as *bodies* differing from all other known bodies in not having weight and occupying a certain space. Thus the poor student employed to "collect" light, etc., has to collect a body that does not occupy a "certain space;" that is, which occupies no space at all, for if it occupied any space it would be a certain one. How an immaterial body which occupies no space can be *produced* by vibrations of an unknown fluid, Mr. Galloway does not try to explain. Mr. Brooke has shown that there is no necessity for imagining an ether penetrating all bodies, in order to explain light, heat, etc.; and all the confusion into which Mr. Galloway has fallen would have vanished, if he had been content to adopt modern ideas, and repre-

sent heat, light, etc., as being most probably merely modes of motion affecting matter.

When we turn to Mr. Kay-Shuttleworth's work we find this branch of the subject treated with much greater simplicity and logical accuracy.

Mr. Galloway discourses of the laws of combination somewhat late in his system, and with a studious preservation of all the old notions which more accurate thinkers have dismissed. We are told, for example, that "affinity causes unlike substances to unite together," and then we have disquisitions on "single elective affinity," "double elective affinity," and so forth, quite in the old style. Nothing can be less desirable than to return to our old metaphysical acquaintance "affinity," with its sham explanations of chemical action. Scientific teaching intended as mental discipline should use no words without definite meaning, and if the cause of an action is unknown, it should make a frank confession of ignorance. Affinity is relationship by marriage, and supposes some sort of resemblance in the objects concerning which it is predicated; and what is the good of saying that relationship of such a nature is a *cause* why two substances unite together. The kind of relationship which *causes* union is moreover said to be *unlikeness*—the most opposite substances being the most ready to combine. Mr. Galloway has had plenty of predecessors in these "affinity" explanations, but repeating old shams is not the best way to teach truth.

Mr. Kay-Shuttleworth explains these actions much better, but he might advantageously modify his statement that "absolute contact" is essential to chemical action—close proximity of atoms is all that we are entitled to assume.

In speaking of the so-called "elementary bodies," Mr. Kay-Shuttleworth very properly explains that he follows Dalton in regarding a substance as elementary until it is decomposed; Mr. Galloway incautiously states that "all substances which do not admit of being separated into simpler forms of matter, because they consist of one material only, are called simple substances or *elements*." He thus confuses together two distinct things, a negative fact, that a substance has not been decomposed, and a positive property, that of elementary composition. What substances are really elementary is not known.

In page 54 Mr. Galloway very properly states, that the "essential nature" of matter is unknown, but a little further on the pupil is asked to "enumerate the essential properties of matter, and the non-essential properties of matter," which in the absence of the knowledge declared not to exist, is impossible. Mr. Galloway probably means to ask for an enumeration of the properties belonging to all matter, and of those which belong to matter in particular conditions, or of particular sorts.

Some of the assertions scattered through the work will stagger many readers—such as the statement that yeast in producing fermentation acts simply by its own decomposition, causing the sugar to do the same, and

that hydrophobia is produced by introducing "putrefying matter" into the system. Part II. comes as a sort of appendix, giving the new views and nomenclature, which the student is expected to learn *after* he has learnt the other arrangements and statements. Now if the new views are more likely than the old ones to be correct, which may be assumed with considerable safety, why not teach them from the beginning, as Mr. Kay-Shuttleworth does in his valuable little work, which deserves great praise, and ought to be completed by extending it to the metals. The student who goes carefully through Mr. Kay-Shuttleworth's small volume will have gained an excellent insight into chemical philosophy as well as have acquired a very useful body of facts. Wherever we find occasion to complain of Mr. Galloway, Mr. Kay-Shuttleworth has merited praise in the corresponding part of his treatise, and though he has confined himself within much narrower limits, he has performed his task with much greater skill.

It should, however, be stated, in justice to Mr. Galloway, that his treatise contains a considerable mass of chemical information, not tainted by the bad philosophy of which we complain.

NOTES AND MEMORANDA.

THE ROTATION-PERIOD OF MARS.—Mr. Proctor gives the elements of his new determination of rotation-period of the planet Mars. A comparison of pictures taken by Mr. Browning in February, 1867, and published in THE INTELLECTUAL OBSERVER for September, with Hooke's observations in March, 1666—giving a period of nearly 201 years—have enabled Mr. Proctor slightly to correct his former estimate, in obtaining which one or two small errors had crept in. He now gives for Mars' sidereal day the period 24h. 37m. 23·73s., in place of the period 24h. 37m. 27·745s. first obtained.

STAR COLOURS AFFECTED BY APERTURE.—In THE INTELLECTUAL OBSERVER for October an account was given of the Lunar eclipse of September 13, and it was remarked that while Mr. Browning described an absence of the usual colours, they were seen by Mr. Slack, who was situated not far from Mr. Browning at the time. The discrepancy was referred to difference of aperture, Mr. Browning having employed a 10¼ silvered mirror, and Mr. Slack one rather less than 6½. Mr. Huggins communicated some important observations on the effect of excess of light in diminishing the visibility of colour. Mr. Browning has since stated (see "Monthly Notices" for December) that "a small star in the cluster in Perseus appears of an indigo blue with 8½ inches, Prussian blue with 10¼ inches, and royal blue with 12¼ inches of aperture." Thus it becomes necessary to state the aperture as well as the colour observed.

THE NEWTON FORGERIES: Fresh Evidence.—Amongst the collection of forgeries in which M. Chasles has unwisely placed such implicit faith, are letters pretending to be written by several of Newton's contemporaries, Huygens amongst the number. M. Harting, of Utrecht, points out ("Comptes Rendus") that the manufacturer of these epistles makes Huygens give an account of his discovery of the ring and satellite of Saturn, and of the rotation-period of the planet, which does not coincide with what he states in his works. M. Martin adduces from letters purporting to be written by Montesquieu specimens of bad French, apparently written by an Englishman, and he thinks

Desmaiseau, to whom Sir D. Brewster ascribes the forgeries, must have had an English assistant. Father Secchi also contributes a letter on this subject, which will be found in "Comptes Rendus," in which he shows that statements made about Galileo and his discoveries are incorrect, representing that philosopher as writing certain things with his own hand at a time when he was incapacitated by blindness. Moreover the matter he is alleged to have written is not consistent with facts. Father Secchi, "as an Italian astronomer, protests against these impostures." Nothing seems to convince M. Chasles, he harps upon the *quantity* of letters in his possession, and makes ineffectual efforts to deal with the overwhelming evidence against him. Probably no scientific man of eminence has ever shown such an unaccountable incapacity to appreciate proof in common affairs.

Excision of the Spleen.—M. Pean describes in "Comptes Rendus" a case in which he removed a diseased spleen from a young woman twenty years of age, who rapidly recovered.

Synthetic Chemistry: formation of Nevrine.—M. Liebreich obtained a crystallizable substance from the brain, which he called *protagon*, which proved to be a compound of phospho-glyceric acid, and a base called *nevrine*, containing, amongst its constituents, phosphorus and nitrogen. M. Baeyer showed that nevrine represented a hydrate of oxethyl-ammonium, in which three atoms of hydrogen were replaced by these methylic groups. M. Wurtz describes in "Comptes Rendus" a method of forming nevrine artificially. For the general reader we may observe that the interest in such questions is not confined to chemists. Every discovery of a process by which complicated compounds resembling, or identical with, those formed in living bodies, can be produced by purely chemical means, throws light upon physiological problems, and refers to the laws of known science actions often vaguely ascribed to "vital force."

New Treatment of Wounds.—M. Guerin has given the French Academy a long account of his method of treating wounds made by surgical operations, or otherwise, by what he calls "pneumatic occlusion" and "aspiration." The first consists in the application of an air-tight cover, and the last in drawing off vapours, etc., that are formed. He reports great success in avoiding fever, etc., and obtaining rapid cures.

Accuracy in Astronomical Observation.—The precision attained by astronomers is truly wonderful. For example, a comparison of the right ascensions of a long list of fundamental stars, as determined at Greenwich and at Paris, shows that the average difference of the two sets of observations is less than a hundredth of one second, being 0s. 007.

Improvements in Electrical Apparatus.—Mr. Browning has devised an improvement in the contact breaker of coil machines which considerably augments their power. It consists in an arrangement by which the hammer is retained much nearer to the soft iron core than when the ordinary break is employed, while the tendency of the contact points to burn is lessened. The details are very simple, but not susceptible of explanation without diagrams. The result is an increase in the length of spark obtained from the coil. The magnetization of the core seems more complete. Mr. Browning has also made a new magneto-electric machine for medical purposes, which is very elegant and efficient. His magnet is bent in a circular curve, and he is thus able to use *one* bobbin instead of two. Thus his currents are always in *one direction*, an important thing in medical use.

ROMAN LADIES AT THEIR TOILETTE.